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(54) Improvements in ice confections and their preparation

(57) Hardened stabilised ice cream confections comprise aerated compositions of ice crystals, edible fat particles and aqueous syrupy phase, shear-frozen under aeration, extruded at nozzle temperatures of about -8°C to -13°C, hardened at -20°C or colder, and contain sugars, sugar alcohols or other low molecular weight materials in amounts molarly equivalent to more than 32% by weight disaccharide, with overruns of 140% or more, and have their hardness at -18°C expressed by log H = 0.85 or less: the confections though storable in the deep-freeze, have eating qualities analogous to those of soft-serve ice cream when eaten direct from the deep freeze.

SPECIFICATION

Improvements in ice confections and processes for their preparation

This invention relates to ice cream confections and methods of making them, and concerns improved confection compositions and their preparation.

A large variety of ice confection products is known with a correspondingly wide range of formulations. Several are described in, for example, GB Specifications Nos.1,456,207; 696,287; and US Patent No. 3,993,793. One popular variant of ice cream is so-called "soft-serve" ice cream. Its preparation is described in, for example, W.S.Arbuckle, "Ice Cream", AVI Publishing Co., 1972, 2nd edition, pp 278-285, 398.

Soft-serve ice cream is prepared and served at −5° to −8°C, and in practice requires preparation and machinery at the place where it is sold and consumed. This need for local preparation is associated with a number of difficulties. For example, it is often hard to ensure adequate microbiological safety standards for the machinery and raw materials. The preparation requires much labour and time. The product has poor keeping qualities: it becomes very hard on deep-frozen storage but at eating temperatures melts down very quickly.

By this invention we provide a stabilised ice cream confection which has been hardened, i.e. equilibrated at deep-freeze temperature, e.g. −20°C or colder (although hardening can also be carried out at ≤ −25°C), and which, however, at −18°C possesses a hardness which corresponds to a log H measurement (as hereinafter described) of less than 0.85, preferably 0.75.

We find surprisingly that an ice cream confection according to the invention has organoleptic properties strikingly similar to "soft-serve" ice cream when it is eaten directly from the deep-freeze, i.e. storage at about -18°C. Its "mouthfeel" and texture characteristics when used in this way prove to be acceptable to consumers in a similar way to the acceptability of soft-serve ice cream.The product has the advantage that it can be prepared at a place remote from the point of sale or consumption (thus, also under clean and supervised factory conditions), and it can be stored at convenience, and eaten direct from storage, with retention of its desirable organoleptic properties. Therefore, it represents a new category of frozen confection.

"Ice cream confection", in this context, means a confection composition consisting of an aerated mixture of ice crystals, fat particles and a syrupy aqueous phase, which has been agitated during freezing (i.e. "shear frozen"). Its fat content is below 15% by weight, normally in the range 6-14%, e.g. about 8% by weight.

A variety of parameters of the formulation can be controlled to ensure the hardness characteristic, as mentioned above, which should be (log H) of 0.85 or less, preferably 0.6-0.75 or even less, e.g. 0.5 but greater than 0.1.

The overrun of an ice cream confection according to the invention should preferably be within the range 140-200%, preferably above 145-150%, e.g. 160%-175%. Although overrun > 200% can be used, this necessitates extra stabilisation and, hence is not preferred.

We have surprisingly found that in certain embodiments of the invention it helps ready achievement of the desired low hardness degrees to extrude the shear-frozen, aerated ice cream confection at about -10°C or below, eg. at colder than −8°C down to about −13°C, in practice at as low a temperaure as can be managed. Otherwise, the physical ice cream processing can be carried out in accordance with the known industrial good practice, e.g. as to homogenisation, pasteurisation, freezing, aeration and extrusion. Conventional ice cream stabilisers such as locust bean gum and carageenan can be used. Furthermore, the ice cream confections according to this invention preferably contain quantities of sugars and/or sugar alcohols or other lowmolecular weight materials, e.g.m.w. ≤600, in quantities molarly equivalent to more than 32% by weight of disaccharide, e.g. above 34% to more than 36%, and for exmple about 38-43%.

The ice content of the ice cream confections at -18°C is then preferably less than 46% by weight, often less than 44%, e.g. in the range 41-44%, for example 42%.

Accordingly, the ice cream confections can be conveniently formulated using greater than normal quantities of freezing point depressants such as sugars or sugar alcohols, e.g. sucrose, glucose, fructose, (e.g. as invert sugar), sorbitol and glycerol. Glycerol is a particularly convenient ingredient at, for example, 1-5% by weight of the formulations, though it must be stressed that good results are achieved by the use of the other ingredients mentioned.

The milk or non-milk fat used in these compositions, the sources of non-fat milk solids, and other optional additives and flavourants (e.g.fruit or other dessert materials), are capable of conventional variation, form no part of the novelty of the present invention, and need no further description.

It can be seen that many of the stabilised ice cream compositions according to the present invention are aerated compositions of ice crystals, edible fat particles and aqueous syrupy phase, which have been shear-frozen under aeration, extruded at nozzle temperatures in the range -8°C to -13°C and hardened (equilibrated) at -20°C or colder, and contain sugars and/or sugar alcohols and/or other low molecular weight materials of m.w. ≤600 in amounts molarly equivalent to more than 32% by weight of disaccharide ($C_{12}H_{22}O_{11}$), with overruns of 140% or more, and at −18°C exhibit hardnesses of log H = 0.85 or less, (when the log H measurement is defined and performed as described below).

Accordingly the invention also provides a process for preparing an ice cream confection, which comprises shear-freezing an aqueous confection mix containing dispersed edible fat and sugars and/or sugar alcohols and/or other low molecular weight materials of m.w. ≤600 in amounts molarly equivalent to a concentration

of disaccharide greater than 32% by weight, aerating the mix to an overrun of at least 140%, and hardening the extruded ice cream at −20°C or colder, to produce a hardened ice cream confection having a hardness corresponding to log H - 0.85 or less.

Log H, as defined in this specification, is the logarithm (base 10) of a hardness measure obtainable by the following or an equivalent test method.

Apparatus

The Instron

The log H measurements were carried out using the Instron Universal Tester model 1122(TradeMark). The sensing table on the Instron was enclosed by a thermostatically controlled temperature cabinet, which operated between a temperature range of +200°C and -70°C. The colder temperatures were obtained by cooling the cabinet with liquid Nitrogen, contained in a self pressurising 50 litre Dewar, which was connected to the back of the cabinet. The ice cream samples could therefore be tested in a temperature controlled environment at any desired temperature. The cabinet was modified to enable easy removal of the load cell. It was also fitted with a glass window panel so that observation of the sample deformation etc. during the measurements was possible.

Measurement

The hardened ice cream samples were tempered in a −18°C cold room for at least 24 hours before any measurements were carried out. The samples were 40 mm thick. Samples were duplicated. Measurements were only carried out when the sample temperature was within ±0.2°C of -18°C, as measured with a standard Comark (Trade Mark) temperature probe.

The sample of ice cream was placed on a platform, which was secured to the sensing table of the Instron with Vaseline, to prevent movement during measurement. The platform contained a "hole" (diameter 31.5 mm) through which the core of the ice cream was forced out as a plunger (diameter 29.46 mm) was pushed through the ice cream at a rate of 20 mm/min. As the plunger moved through the ice cream a shear force (in Newtons) was recorded on the Instron trace. H is the maximum force recorded, and is conveniently quoted as a logarithm, log H.

Particular and non-limitative embodiments of the invention will be illustrated further by the following examples.

EXAMPLE 1

An ice cream confection was formulated as follows:

	%(weight)
Spray-dried milk powder	9.42
Whey powder	1.11
Sucrose	14.12
Glycerol	5
Maltodextrin(40 DE)	2.82
Butter	7.45
Mono/Di-glycerides of palm oil	0.45
Locust bean gum	0.2
Carragel MS 20 (Trade Mark, from Bulmers) (Carrageenan)	0.03
Dairy colour and flavour	0.035
Water	to 100

The processing followed conventional good practice except for the following processing conditions:

Overrum = 170%;

Extrusion temperature = −12°C.

After the extruded product had been hardened at −20°C overnight, measurement as described above showed that its log H at −18°C was 0.70±0.02.

The product of the Example had good stability and was a firm hardened ice cream after deep-freeze storage, but its softness (log H = 0.70) was such that it had the organoleptic qualities of soft-serve ice cream directly on consumption from the deep-freeze, with good mouthfeel, flavour and texture characteristics.

EXAMPLES 2-4

Further ice cream confections were prepared as in Example 1 but formulated as follows:

Example No.:	2	3	4
Spray dried skim milk powder	9.42%	9.42%	11.84%
Whey powder	1.1 %	1.1 %	–
Sucrose	14.12%	14.12%	12 %
Glycerol	3 %	1 %	1 %
Dextrose monohydrate	3 %	6 %	7 %
Maltodextrin (40 DE)	2.82%	2.82%	–
Coconut oil	8 %	8 %	8 %
Mono/diglycerides of palm oil (Admul MGP, Food Industries Ltd., Bromborough, England)	0.45%	0.45%	0.45%
Locust bean gum (LBG)	0.2 %	0.2 %	0.2 %
Carrageenan (Carragel MS 20) (Trade Mark)	0.03%	0.03%	–
Dairy colour and flavour	0.03%	0.03%	0.03%
Water	to 100	% in each case	

The textural and organoleptic results in each case were acceptably similar to those obtained in Example 1; overruns used were 160%-170%, extrusion temperatures -10° to -12°C, and hardness levels obtained correspond to log H in the range 0.7-0.8.

EXAMPLES 5 and 6

Further ice cream confections were prepared as in the preceding Examples 2-4 but formulated as follows:

Example No.:	5	6
Spray dried skim milk powder	12 %	9.42%
Whey powder	1.5%	1.11%
Sucrose	15 %	14.12%
Fructose	2 %	-
Dextrose monohydrate	3 %	-
Corn syrup (40 DE)	4.5%	2.82%
Glycerol	-	2 %
Invert sugar (75% solids)	-	5.36%
Coconut oil	8 %	8 %
Mono/Diglycerides of palm oil	0.45%	0.45%
locust bean gum (LBG)	0.2 %	0.2 %
Carrageenan	0.03%	0.03%
Dairy colour and flavour	0.03%	0.03%
Water	100% in each case	

Similar textural and organoleptic results were obtained to those of Examples 2-4.

CLAIMS

1. A stabilised ice cream confection which has been hardened (as hereinbefore defined) and which has a hardness at -18°C which corresponds to a log H measurement (as hereinbefore defined) of at most0.85.
2. An ice cream confection according to claim 1 in which the log H measurement is at most 0.75.
3. An ice cream confection according to claim 1 in which the log H measurement if in the range 0.6-0.75.
4. An ice cream confection according to any preceding claim in which the overrun is in the range 140-200%
5. An ice cream confection according to claim 4 in which the overrun is at least 145%.
6. An ice cream confection according to claim 4 in which the overrun is at least 150%.
7. An ice cream confection according to claim 4 in which the overrun is in the range 160-175%.
8. An ice cream confection according to any preceding claim which has been extruded at a temperature colder than -8°C.

9. An ice cream confection according to claim 8, which has been extruded at a temperature in the range below -8° to -13°C.

10. An ice cream confection according to claim 8 which has been extruded at a temperature in the range -10°C to -12°C.

11. An ice cream confection according to any preceding claim, containing sugar and/or sugar alcohol and/or other low-molecular weight edible compounds of m.w. <600, in an amount more than the molar equivalent of 32% by weight of disaccharide $C_{12}H_{22}O_{11}$.

12. An ice cream confection according to claim 11, in which said amount is the molar equivalent of at least 34% disaccharide.

13. An ice cream confection according to claim 11 in which said amount is the molar equivalent of at least 36% disaccharide.

14. An ice cream confection according to claim 11 in which said amount is the molar equivalent of 38% - 43% disaccharide.

15. An ice cream confection according to claim 11, containing 1-5% glycerol by weight.

16. An ice cream confection according to claim 11, containing glycerol, sorbitol, fructose or invert sugar.

17. An ice cream confection according to any preceding claim, which has an ice content of less than 46% by weight at -18°C.

18. An ice cream confection according to claim 17, which has an ice content of less than 44% by weight at -18°C.

19. An ice cream confection according to claim 17, which has an ice content in the range 41%-44% by weight at -18°C.

20. An ice cream confection according to claim 17, which has an ice content of about 42% at -18°C.

21. A process of producing an ice cream confection which comprises hardening (as hereinbefore defined) an ice cream confection to a hardness which at −18°C corresponds to a log H measurement (as hereinbefore defined) of at most 0.85.

22. A process according to claim 21, in which the ice cream is hardened to a hardness as defined in claim 2 or 3.

23. A process according to claim 21, wherein the iece cream confection has the characteristics defined in any one of claims 4 to 18.

24. An ice cream confection substantially as hereinbefore described with respect to any one of the Examples.

25. A process according to claim 21 substantially as hereinbefore described with respect to any one of the Examples.

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Title: Frozen ice cream dessert and process for making

Abstract: Source: US6558729B A frozen dessert which is spoonable at freezing temperatures and/or packageable in pressurized containers is disclosed. The frozen dessert has dairy proteins, fats, sweeteners, one or more stabilizing agents, flavoring agents or coloring agents. The proteins are provided by dairy milk products or skimmed milk. The fat is a vegetable oil with a very low freezing point. The sweeteners are a mixture of low molecular weight sweetening agents such as dextrose and/or fructose, invert sugar and glucose syrup.

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(54) DESSERT GLACE.

(57) La présente invention concerne un dessert glacé susceptible d'être cuillérable à température de congélation et/ou d'être conditionné dans des récipients sous pression.

Le dessert glacé selon l'invention dont la composition comprend des protéines d'origine laitière, des matières grasses, des matières sucrantes, un ou des agents stabilisants et des agents aromatisants ou colorants se distingue notamment en ce que :

- les protéines sont apportées par des produits lacto-remplaceurs d'origine laitière et/ou du lait écrémé ;
- la matière grasse est une huile végétale à très bas point de congélation ;
- les matières sucrantes sont un mélange d'agents sucrants de faible poids moléculaire tels que :
  dextrose et/ou fructose, sucre inverti, sirop de glucose.

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La présente invention concerne un dessert glacé. Le dessert glacé selon l'invention est du type comprenant essentiellement des proteînes d'origine laitière, des matières grasses, des agents sucrants et un ou des agents stabilisants.

Le dessert glacé selon l'invention pourra, selon les besoins, contenir des agents aromatisants, des agents colorants ou des inclusions comestibles.

Ces produits sont habituellement obtenus par congélation des composants ci-dessus énoncés et leur conservation jusqu'à consommation suppose le maintien en froid négatif, la température de congélation pouvant aller jusqu'à moins 18°, et même moins 24° centigrades.

De ce fait, les produits obtenus sauf à subir une période de réchauffement, présentent une consistance particulièrement dure qui empêche leur consommation immédiate et rend leur division à la cuillère impossible ou du moins difficile.

Dans le cas de portion importante, lorsque la portion n'a pas été entièrement consommée, sa conservation après réchauffement pour division, suppose une recongélation qui a des incidences sur la structure du produit avec réalisation de gros cristaux donnant en bouche un goût acqueux et une texture plus dure et présente des risques bactériologiques.

De plus, ces produits après décongélation jusqu'à température de consommation perdent une partie de leurs propriétés de stabilité et de leurs qualités gustatives.

L'art antérieur a proposé des solutions :

Le brevet GB 1563191 se propose de réaliser une crême glacée qui est cuillérable à température de congélation et dont la composition contient à la fois des agents stabilisants et des produits du type glycerol qui abaissent le point de congélation.

Le brevet GB 2019187 décrit une préparation analogue au brevet précédent dans lequel outre les stabilisants et les produits du type glycerol, les agents sucrants utilisés sont des agents sucrants à faible poids moléculaire du type sucrose, glucose, fructose, sucre inverti qui entrent dans la composition pour leur capacité à abaisser son point de congélation.

Il est apparu que fréquemment les stabilisateurs doivent être utilisés dans de telles proportions que la perception en bouche et le goût du produit obtenu peuvent être altérés de même que son aspect qui peut devenir gommeux avec un goût de gras.

De même, l'utilisation d'agents sucrants à faible poids moléculaire peut affecter le goût du produit si la composition des agents sucrants n'est pas étroitement maitrisée.

Les polyols ou glycerols utilisés pour abaisser le point de congélation présentent en outre l'inconvénient de n'être pas digestibles par l'homme et d'avoir des effets laxatifs.

La présente invention vise à obvier à ces inconvénients tout en permettant la réalisation d'un dessert

glacé cuillerable à température de congélation et susceptible d'être conditionné en récipient sous pression. Ce résultat est obtenu par une sélection de la matière grasse d'origine végétale à très bas point de fusion et par la sélection d'un mélange de matières sucrantes spécifiques à faible poids moléculaire et par mélange avec des proteïnes d'origine laitières.

A cet effet, le dessert glacé selon l'invention dont la composition comprend des proteïnes d'origine laitière, des matières grasses, des matières sucrantes et un ou des agents stabilisants se caractérise essentiellement en ce que :

- les proteïnes sont apportées par des produits lacto-remplaceurs d'origine laitière et/ou du lait écrémé comprenant 20% à 40% de proteïnes par rapport au produit brut ;
- la matière grasse utilisée est une huile d'origine végétale à bas point de fusion ;
- les matières sucrantes sont un mélange d'agents sucrants à faible poids moléculaire, ledit mélange comprenant dextrose et/ou fructose, sucre inverti et sirop de glucose.

Suivant une autre caractéristique de l'invention, le mélange de matières sucrantes comprend :

- dextrose et/ou fructose,
- sucre inverti,
- sirop de glucose,

et dans lequel,

- le sucre inverti a un pourcentage d'inversion égal élevé par exemple égal à 93 plus ou moins 3 ;

- le sirop de glucose a un dextrose équivalent de l'ordre de 70% par exemple compris entre 69,7 et 73,7%.

D'autres avantages et caractéristiques de l'invention apparaîtront à la lecture de la description ci-après de l'invention et de son procédé de mise en oeuvre.

Le dessert glacé selon l'invention est du type réalisé par un mélange de proteînes d'origine laitière, de matières grasses et de matières sucrantes.

Ce mélange est destiné à être congelé après réalisation et à être distribué en état de congélation au consommateur, soit en portion individuelle, soit en ration à diviser en portion, soit en emballage sous pression.

Le produit selon l'invention peut également être distribué sous forme liquide traitée UHT et être soumis à congélation par l'utilisateur.

La difficulté à solutionner est :

- premièrement de réaliser un produit qui dans la plage de température de moins 18° centigrades à moins 24° centigrades, soit à la fois suffisamment souple pour être cuillerable ou passer sous pression au travers une buse d'un récipient dans lequel le produit est conditionné en pression ;
- deuxièmement, de réaliser un produit stable physiquement pendant le temps de consommation tout en présentant les qualités organoleptiques d'une glace.

L'idée de départ a été de jouer sur les trois composants fondamentaux, sucres, matières grasses et proteînes, sur leurs pourcentages relatifs et sur la nature

des dits composants et/ou des ingrédients de chacun d'eux afin d'abaisser le point de congélation du mélange.

Il est apparu que les ingrédients proteîques ont une influence essentiellement sur la stabilité et la texture de la glace, notamment en sortie de buse lorsqu'elle est conditionnée en récipient sous pression.

Il est apparu que la nature des ingrédients proteîques, lait écrèmé ou lactoremplaceurs, le taux d'incorporation et la composition des ingrédients proteîques ont une influence sur la texture de la glace à température de congélation.

Il est apparu au cours des essais que le taux d'ingrédients proteîques devait être compris entre 8% et 15%.

En-dessous de 8%, la texture du produit est bien fluide mais celui-ci manque de tenue et de stabilité.

Au-dessus de 15%, le produit est trop ferme.

Dans la fourchette de 8% à 15%, le produit reste malléable en étant plus ferme si on augmente le taux de proteînes.

Les produits proteîques peuvent être constitués de lactoremplaceurs seuls ou d'un mélange de lactoremplaceurs et de lait écrèmé en poudre ou de ce dernier ingrédient seul.

Avantageusement, les lactoremplaceurs sont des produits en poudre d'origine laitière composés principalement de proteînes d'origine sériques et comprenant 20% à 40% de proteînes.

Les pourcentages mentionnés sont donnés de poids en poids.

Différentes matières sucrantes ont été testées en

remplacement du saccharose, ces matières étant de poids moléculaire plus faible pour abaisser le point de congélation.

Trois types de mélanges de matières sucrantes ont été déterminés à cet effet qui donnent sensiblement le même résultat au niveau de la texture cuillerable mais différent par la saveur sucrée.

Le premier mélange ou première combinaison comprend un pourcentage total de sucres exprimés par rapport à la formule globale de 24,6% en matières sèches, dont :

- dextrose ou fructose : 8,2%,
- sucre inverti : 8,2%,
- sirop de glucose : 8,2%.

Avec ce type de mélange, la saveur sucrée est assez accentuée.

Le deuxième mélange ou deuxième combinaison présente un pourcentage total de sucres exprimés par rapport à la formule globale de 20,3% en matières sèches dont :

- dextrose ou fructose : 10,0%,
- sucre inverti : 3,3%,
- sirop de glucose : 7,0%.

Avec ce deuxième type de mélange, la saveur sucrée est moins intense qu'avec le premier.

Le troisième mélange ou troisième combinaison d'agents sucrants comprend un total de sucres exprimés par rapport à la formule globale de 20,3% en matières sèches, dont :

- dextrose ou fructose : 13,3%,
- sirop de glucose : 7,0%.

Le sirop de glucose utilisé a une composition hydrocarbonnée comprenant environ 49% de glucose et 26% de saccharides.

Le sucre inverti est caractérisé par un degré d'inversion élevé (pourcentage de saccharose hydrolysé) de l'ordre de 93% plus ou moins 3%.

Le sirop de glucose utilisé présente un dextrose équivalent de l'ordre de 70% par exemple compris entre 69,7% et 73,7%.

La matière grasse utilisée est l'un des principaux facteurs jouant sur la texture finale du produit et dans l'obtention d'une texture qui ne soit pas, à température de congélation, trop ferme.

Différents essais ont démontré que la matière grasse à bas point de congélation la plus apte était l'huile de tournesol dont la solidification débute à environ moins cinq degrés centigrades pour être totale à environ moins vingt cinq degrés centigrades.

Cette huile est caractérisée par un bas point de fusion.

Les pourcentages d'incorporation optimum pour parvenir au résultat escompté sont compris entre 8% et 20%.

En dessous de 8%, le produit obtenu est trop ferme, ce qui notamment le rend impropre à un conditionnement en récipient sous pression.

Au-delà de 20%, le produit obtenu est malléable mais avec un aspect filant et n'a pas en bouche le goût d'une crême glacée.

Entre 8% et 20%, plus on augmente la proportion d'huile de tournesol et plus la glace est souple et fluide

et plus elle a de corps en bouche lors de la dégustation.
Il va de soi que d'autres matières grasses d'origine végétale à caractéristiques équivalentes à celles de l'huile de tournesol sont susceptibles d'être utilisées.

Une composition type du produit selon l'invention peut être la suivante :

- huile de tournesol : 16,5% à 18,5%,
- lait écrémé en poudre :
  (ou lactoremplaceur) : 11,6% à 10%,
- dextrose : 13,3%,
- sirop de glucose : 8,8%,
- stabilisant : 0,6% à 0,3%,
- lait écrémé liquide : 49,0% à 49,1%.

Suivant une autre forme de réalisation de l'invention, il est possible d'intégrer à la composition des polyols ou sucre alcool.
A titre d'exemple, un sorbitol peut être ajouté dans une proportion de 3 à 5% ; dans ce cas, la proportion de dextrose est de 10,3% à 8,3%.

La mise en oeuvre des ingrédients s'effectue en préparant tous les constituants sous forme liquide, le lait écrémé liquide et l'huile de tournesol.
Les constituants liquides sont soumis à un mélange à chaud sous l'action d'un fouet.
La température est portée jusqu'à 50°.
A cette température sont alors apportés le lait écrémé en poudre et les stabilisants en poudre.
Les stabilisants sont un mélange de mono et diglycérides

d'acides gras avec éventuellement de la caroube, guar, carraghénates, alginates, gélatine, etc...

Les stabilisants sont choisis de façon à adapter la texture et la stabilisation du dessert glacé.

Cet apport se fait sous agitation.

Le mélange est porté à une température comprise entre 65°C à 70° centigrades afin de bien solubiliser les agents stabilisants.

Les sucres sont alors ajoutés et la température est portée ou maintenue à 70°C.

L'extrait sec est alors ajusté aux alentours de 45% avec de l'eau.

Il est également possible de ne chauffer que le lait écrémé liquide et d'ajouter l'huile de tournesol après le lait écrémé en poudre et le stabilisant.

La préparation est ensuite homogénéisée au moyen d'un polybroyeur pour obtenir une distribution homogène de globules gras de petit diamètre.

La préparation est ensuite soumise à maturation pendant un temps variant de quelques heures à une nuit en froid positif par exemple à +3°C.

Cette maturation peut s'effectuer conjointement à un brassage du produit.

La préparation peut ensuite être surgelée directement avec un foisonnement conjoint ou traitée UHT puis mise en récipient sous pression et surgelée ensuite.

La mise en récipient sous pression peut également être effectuée directement après pasteurisation ou

traitement UHT, la maturation et la congélation intervenant ensuite.

La surgélation s'effectue soit par la technique de la surgélation mécanique, soit par surgélation cryogenique.

La conservation du produit obtenu s'effectue en enceinte réfrigérée à température comprise entre moins 18° centigrades et moins 24° centigrades.

Le conditionnement peut en fonction des conditions de commercialisation et d'emploi être effectué en pot ou en récipient sous pression.

Les récipients sous pression peuvent être du type siphon ou du type bombe à pression. Dans ces cas, un gaz foisonneur est injecté dans le produit, celui-ci est généralement un gaz neutre du type protoxyde d'azote.

Un gaz propulseur, par exemple de l'azote, est également injecté jusqu'à la pression nécessaire dans le récipient.

REVENDICATIONS :

1. Dessert glacé dont la composition comprend des proteînes d'origine laitière, des matières grasses, des matières sucrantes, un ou des agents stabilisants caractérisé en ce que :

- les proteînes sont apportées par des produits lacto-remplaceurs d'origine laitière et/ou du lait écrémé comprenant 20 à 40% de proteînes par rapport au produit brut ;
- la matière grasse est une huile d'origine végétale à bas point de fusion ;
- les matières sucrantes sont constituées par un mélange d'agents sucrants à faible poids moléculaire, ledit mélange comprenant dextrose et/ou fructose, sucre inverti et sirop de glucose.

2. Dessert glacé selon la revendication 1 dont la composition comprend :

- des proteînes d'origine laitière,
- des matières grasses,
- des matières sucrantes,
- un ou des agents stabilisants,

caractérisé en ce que :

- les proteînes sont apportées par des produits lacto-remplaceurs d'origine laitière et/ou du lait écrémé comprenant 20 à 40% de proteînes par rapport au produit brut ;
- les matières sucrantes sont un mélange d'agents sucrants à faible poids moléculaire, ledit mélange comprenant :

- dextrose et/ou fructose,

- sucre inverti,

- sirop de glucose, dans lequel le sucre inverti a un pourcentage d'inversion élevé de l'ordre de 93 plus ou moins 3 et le sirop de glucose a un dextrose équivalent de l'ordre de 70%.

3. Dessert glacé selon la revendication 1 caractérisé en ce que :

- les lactoremplaceurs comprennent de 20 à 40% de proteines par rapport au produit brut.

4. Dessert glacé selon la revendication 1 caractérisé en ce que l'huile végétale est une huite à bas point de fusion.

5. Dessert glacé selon la revendication 1 caractérisé en ce que l'huile végétale est une huile de tournesol.

6. Dessert glacé selon la revendication 1 caractérisé en ce que le sucre inverti utilisé se caractérise par un pourcentage de degré d'inversion élevé de l'ordre de 93 plus ou moins 3.

7. Dessert glacé selon la revendication 1 caractérisé en ce que le sirop de glucose a un dextrose équivalent de l'ordre de 70%.

8. Dessert glacé selon la revendication 1 caractérisé en ce que le sirop de glucose a une composition hydrocarbonée comprenant 49% de glucose et 26% de saccharides.

9. Dessert glacé selon la revendication 1 et l'une

quelconque des revendications 2 à 8 caractérisé en ce qu'il comprend :

- huile de tournesol : 16,5% à 18,5%,
- lait écrémé en poudre :
  (ou lactoremplaceur) : 11,6% à 10%,
- dextrose : 13,3%,
- sirop de glucose : 8,8%,
- stabilisant : 0,6% à 0,3%,
- lait écrémé liquide : 49% à 49,1%.

10. Dessert glacé selon la revendication 9 caractérisé en ce que le mélange d'agents sucrants présente un pourcentage total de sucres exprimés par rapport à la formule globale de 24,6% en matières sèches, dont :

- dextrose ou fructose : 8,2%,
- sucre inverti : 8,2%,
- sirop de glucose : 8,2%.

11. Dessert glacé selon la revendication 1 caractérisé en ce que le mélange d'agents sucrants présente un pourcentage total de sucres exprimés par rapport à la formule globale de 20,3% en matières sèches, dont :

- dextrose ou fructose : 10,0%,
- sucre inverti : 3,3%,
- sirop de glucose : 7,0%.

12. Dessert glacé selon les revendications 1 et 2 caractérisé en ce que le taux de proteînes est compris entre 8 à 15%.

13. Dessert glacé selon la revendication 1 caractérisé en ce que l'agent stabilisant est incorporé dans

une proportion comprise entre 0,25% à 0,8%.

14. Dessert glacé selon la revendication 1 caractérisé en ce que le mélange d'agents sucrants comprend un total de sucres exprimés par rapport à la formule globale de 20,3% en matières sèches, dont :

- dextrose ou fructose : 13,3%,
- sirop de glucose : 7,0%.

15. Procédé de fabrication d'un dessert glacé mettant en oeuvre les composants selon les revendications 1 à 14 caractérisé en ce que :

- le lait écrémé liquide et l'huile sont mélangés (sous forme liquide) et conjointement chauffés jusqu'à une température de 50° centigrades ;
- le lait écrémé en poudre et l'agent stabilisant sont alors apportés, le mélange étant porté à une température de 65°C à 70°C ;
- les agents sucrants sont ajoutés lorsque le mélange est à 70°C ;
- l'extrait sec est ajusté aux alentours de 45% d'eau si nécessaire ;
- la préparation est homogénéisée ;
- la préparation subit une maturation sous froid positif avec éventuellement une agitation ;
- la préparation est surgelée pour avoir une température finale comprise entre -18°C et -24°C.

16. Procédé de fabrication selon la revendication 15 caractérisé en ce que le mélange peut être conditionné sous pression.

17. Procédé de fabrication selon les revendications 15 et 16 caractérisé en ce que le conditionnement sous pression s'effectue après maturation du mélange et avant surgélation.

18. Procédé de fabrication selon les revendications 15 et 16 caractérisé en ce que le conditionnement sous pression s'effectue après surgélation et foisonnement.

19. Procédé de fabrication selon la revendication 15 caractérisé en ce que le mélange est conditionné à la pression atmosphérique en pots après surgélation et foisonnement.

REPUBLIQUE FRANÇAISE

INSTITUT NATIONAL de la PROPRIETE INDUSTRIELLE

RAPPORT DE RECHERCHE PRELIMINAIRE

établi sur la base des dernières revendications déposées avant le commencement de la recherche

2745153
N° d'enregistrement national

FA 526095
FR 9602527

DOCUMENTS CONSIDERES COMME PERTINENTS

Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	Revendications concernées de la demande examinée
X Y	US-A-4 400 406 (R. G. MORLEY ET AL.) 23 Août 1983 * colonne 3, ligne 40-68; exemple 6 * * colonne 5, ligne 41 - colonne 6, ligne 30 * * colonne 7, ligne 1 - colonne 8, ligne 31 *	1,3-5, 12,13 15
Y	US-A-5 084 295 (R. H. WHELAN ET AL.) 28 Janvier 1992 * revendications 1,9; exemples 1,2 *	15
X A	US-A-4 421 778 (M. L. KAHN ET AL.) 20 Décembre 1983 * revendications 1,3,5-7,12-15,31-34; exemples * * colonne 1, ligne 52 - ligne 59 * * colonne 3, ligne 35 - colonne 5, ligne 56 *	1,2 3
A	US-A-4 244 977 (M. L. KAHN ET AL.) 13 Janvier 1981 * le document en entier *	1,15
X	US-A-4 853 243 (M. L. KAHN ET AL.) 1 Août 1989 * colonne 1, ligne 35-46; exemples * * colonne 7, ligne 50 - colonne 8, ligne 31 *	1
X	GB-A-1 563 191 (UNILEVER) 19 Mars 1980 * page 2, ligne 120-124; exemples 1,2 * * page 2, ligne 3-108 *	1,3,4, 12,13
A	GB-A-2 019 187 (UNILEVER) 31 Octobre 1979 * le document en entier *	1

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DOMAINES TECHNIQUES RECHERCHES (Int.CL.6)

A23G

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Date d'achèvement de la recherche	Examinateur
6 Décembre 1996	Guyon, R

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Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	Revendications concernées de la demande examinée
A	FR-A-2 187 234 (UNILEVER) 18 Janvier 1974 * Exemples 33-41, 47, 48, 87-98 * ---	15
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 108 (C-180), 11 Mai 1985 & JP-A-60 002151 (AZAKI ATSUKO), 8 Janvier 1985, * abrégé * ---	1
A	US-A-4 808 428 (S. L. FORSSTROM ET AL.) 28 Février 1989 * colonne 3, ligne 5-11; exemples * * colonne 4, ligne 40-62 * * colonne 1, ligne 1-10 * ---	1
A	US-A-4 552 773 (M- L- KAHN ET AL.) 12 Novembre 1985 -----	

DOMAINES TECHNIQUES RECHERCHES (Int.CL.6)

1

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(54) **Soft-frozen water-ice formulation.**

(57) An aerated soft-frozen, fat-free water-ice product which is extrudable at 0 to 10°F, said product containing a critical level of chemical emulsifier in order to effect desirable textural characteristics.

EP 0 220 836 A2

Case 3441

SOFT-FROZEN WATER-ICE FORMULATION

BACKGROUND OF THE INVENTION

This invention provides a new frozen novelty product, principally for dessert or snack use, that emulates the textural and rheological characteristics of soft ice cream while at home freezer temperatures (e.g. 0° F to 10°F). The invention embraces a combination of ingredients which define a new soft, frozen water-ice product.

Soft serve ice creams or soft serve ice milks are popular desserts with wide appeal. Distinguishing features of these soft serve products are that they are frozen in a special soft serve freezer, are dispensed by extrusion at carefully chosen subfreezing temperatures and they stand up in a cone or dish upon extrusion. Conventional soft serve products are usually dispensed at an overrun on the order of 40% to 60%. Soft serve products of this character have been known for many years, however, its availability is primarily from stores having special freezers that dispense the product for immediate consumption.

These soft serve products must be dispensed at temperatures between 16°F and 24°F (-9°C to -4°C). At lower temperatures, the product is no longer soft. Conventional soft serve products accordingly are not suited for sale from grocery store freezers for home storage and use. Home freezers maintain temperatures generally around 0°F to 10°F (-18°C to -12°C), and store freezers, which as used herein includes grocery store, supermarket, and restaurant freezers, are generally kept at colder temperatures.

Considerable effort has been expended to develop a soft serve product for home use. U.S. Pat. No. 4,244,977 to Kahn, U.S. Pat. No. 4,219,581 to Dea et al., U.S. Pat. No. 4,145,454 to Dea et al., and U.S. Pat. No. 3,993,793 to Finney and U.K. Patent Specification No. 1,508,437 disclose frozen food products which supposedly are softer than conventional ice cream at freezer temperatures. There is considerable other published art on the subject of frozen desserts, particularly ice cream. A pertinent text is Ice Cream, Second Edition by W.S. Arbuckle, Ph.D., published in 1972 by the Avi Publishing Company, Inc., Westport, Conn.

U.S. Patents 4,374,154 and 4,452,824 to Cole et al. describe formulations for producing soft-from-the-freezer, fat-containing ice cream formulations which possess a highly desirable combination of softness extrudability and storage stability. Both these patents are herein incorporated by reference.

DESCRIPTION OF THE INVENTION

This invention relates to an aerated, storage-stable, fat-free dessert product which is sufficiently soft from a home freezer (0°F to 10°F) to be

extrudable. These products can be dispensed by hand from a collapsible package having an extrusion orifice. A squeeze package or a package having a mechanism to assist in applying pressure to the product may be utilized. The products of this invention have a high tolerance to freeze-thaw cycling and are able to be stored for prolonged periods between -10°F and +10°F without significant growth of ice crystals. The fat-free formulations encompassed within the scope of this invention contain a combination of mono-, di-, and polysaccharides, chemical emulsifiers and stabilizers in order to achieve a desirable level of freezer softness and storage stability. Various flavor and color agents, fruit solids, such as from fruit juices and fruit purees, and food acids may also be included in these formulations. All percentages and ratios given in this disclosure (except % overrun) are given as weight percents, unless otherwise indicated. The formulations of this invention are preferably free of all dairy ingredients such as non-fat milk solids, whey, lactose, etc. and are also preferably protein-free. Fruit pieces such as whole fruit pieces or pieces of infused whole fruit which would constitute a discontinuous or mix-in phase are not part of the base water ice formulations of this invention.

According to this invention the base formulations contain a water level of from about 50 to 68%, a total carbohydrate level, including carbohydrate present in any included fruit solids, of from 28 to 45%, food acids at a level of up to 1%, preferably from 0.2 to 0.8%, chemical emulsifiers in an amount of from 0.05 to 0.4% and hydrocolloid stabilizer at a level of up to 0.5%, preferably from 0.1 to 0.4%.

It has further been found that the formulations must contain a minimum of polysorbate 80, a well-known and commercially-available mixture of polyoxyethylene esters of mixed partial oleic esters of sorbitol anhydrides, as all or part of the chemical emulsifier component.

The ratio of higher saccharides to the combined mono- and disaccharides and the ratio of disaccharides to monosaccharides fulfill the relationship set forth in U.S. Patents 4,374,154 and 4,452,824. More specifically, the weight ratio of higher saccharides (i.e., three or more saccharide units) to mono and disaccharides (Ratio 1) and the weight ratio of disaccharides to monosaccharides must satisfy the relationship of $7 \leq (28 \times \text{Ratio } 1) + \text{Ratio } 2 \leq 28$. Preferably Ratio 1 and Ratio 2 satisfy the relationship $24 \leq (80 \times \text{Ratio } 1) + (3 \times \text{Ratio } 2) \leq 64$, and further it is desirable that Ratio 1 possesses a value of from 0.25 to 0.45 and the Ratio 2 have a value of from 0.90 to 9.0. In the case of formulations which contain polyols and sugar alcohol ingredients it may be further desirable that $11 \leq (28 \times \text{Ratio } 1) + \text{Ratio } 2 \leq 28$, that $34 \leq (80 \times \text{Ratio } 1) + (3 \times \text{Ratio } 2) \leq 64$ and/or that Ratio 1 is from 0.36 to 0.70.

When formulating in accordance with this invention, sufficient low molecular weight saccharides are present to depress the freezing point of the formulation several degrees but not sufficient to preclude the formation of ice crystals during product preparation. An absence of ice crystals is undesirable since the product will then not provide the desired and expected coldness impact which the consumer associates with the experience of eating sherbet or water-ice.

The formulation and processing parameters of this invention combine to yield a fruit-flavored, fat-free water-ice product having a smooth texture comparable to this present in conventional sherbet products. The formulations of this invention are prepared using conventional mixing techniques and are frozen using continuous freezing equipment. The products will have an overrun of from about 20 to 100% and an ice crystal size comparable to that present in conventional ice cream and sherbets.

The term "carbohydrate" or "saccharide" as used in this disclosure is meant to include soluble compounds composed of carbon, hydrogen and oxygen in which the latter two elements are in the same proportion as in water as well as functionally equivalent materials such as sugar alcohols (e.g., mannitol, sortitol, etc.) and polyhydric alcohols (e.g., glycerol). Thus the terms include sugars (e.g., dextrose, fructose, galactose, sucrose, etc.), starch hydrolyzates, polyols and the like. Macromolecular carbohydrates, such as natural gums (e.g., locust bean guar, etc.) which may be incorporated as stabilizers at low levels within the product formulations are not to be included when calculating carbohydrate level or saccharide distribution in accordance with this invention.

According to this invention, it is possible to formulate soft from the freezer fat-free, water-ice products which possess the organoleptic properties of taste, texture and mouthfeel of conventional soft serve ice cream. The products of this invention have the ability to be extruded as a continuous ribbon via manual pressure immediately upon removal from a freezer as cold as 0°F. These products will

also be tolerant to extended freezer storage of several months and repeated thermal shocks without a significant deterioration of the ice crystal structure. In other words the products of this invention are resistant to the development of large ice crystals during prolonged storage such as would be required for the commercial distribution of the product over large geographical areas and the subsequent storage of the product in the home. Further the normal temperature variations and/or cycling which occur in commercial and household freezer equipment, especially those with frost-free operations, will not destroy the texture of the product.

The soft-frozen water ices of this invention possess unique texture and extrusion properties. The emulsifier system present in the fat-free and protein-free formulations of this invention unexpectedly contribute to providing a smooth texture, an ability to incorporate and maintain overruns in excess of 20% and improved extrusion properties. In the absence of the emulsifier system of this invention the product was hard to extrude, would not incorporate air above 20% overrun and had a coarse texture. It has been found that the addition of polysorbate 80 either alone or in combination with other emulsifiers is critical to the manufacture of a product which is perceived by the consumer as having the smooth texture of a fat and protein-containing sherbet products. The level of polysorbate 80 in the water ice formulation should be equal to or greater than 0.001% and preferably be equal to or greater than 0.01%.

A study was conducted to establish the effect of the presence of polysorbate 80 in fat-free and protein-free water ice formulations. A standardized base formulation having the following composition was utilized for this study.

Component	Weight %
Water	63.46
Corn Syrup Solids	14.87
Dextrose	12.79
Sucrose	7.81
Stabilizer	0.30
Citric Acid	0.25
Emulsifier (as described below)	-----

Each formulation was passed through a continuous ice cream freezer where air was injected and the formulation was partially frozen. This partially-frozen material was then packed into single-service, extruder packages which contained a cone-shaped body portion and a preformed extrusion nozzle or fitment bonded to the open end of the cone. The force required to extrude the formulation from the cones at 5°F (-15°C) was obtained via a standardized testing methodology using an extrusion cell which measures the force in kilograms necessary to extrude the water ice product from the cone. All extrusion force measurements were made on duplicate cones and averaged. The overrun for all products which were extruded was 40% with the exception of 0% emulsifier level product where an overrun of 10% was the maximum level achievable.

TABLE 1

Emulsifier Level	Extrusion Force in Kg at 5°F
0 No Emulsifier	6.55
0.03 Polysorbate 80	2.58
0.14 (80% mono and diglycerides 20% Polysorbate 80)	3.3
0.10 Polysorbate 80	2.6
0.18 (mono and diglycerides)	5.35
0.14 (sorbitan monostearate)	7.1

Based on a correlation which has been established between instrumental and sensory measurement of extrusion forces, using a panel of six judges, it has been found that instrumental extrusion forces of about 4 kg represent samples which are moderately easy to extrude by an average individual. Extrusion force measurements of about 5.5 kg represent sample water ice products which are difficult to to extrude and extrusion forces of 7.0 or above represent products which are impossible to extrude. As can be seen from the results set forth in Table 1, conventional mono and diglyceride chemical emulsifiers and and monostearate chemical emulsifiers do not produce an extrudable water ice product, whereas relatively low levels of polysorbate 80 are found to produce readily extrudable, fat-free and protein-free water ices.

The process for producing the soft, frozen water-ice formulations of this invention involve steps known in the manufacture of ice cream. Thus water and most of the dry ingredients are mixed together and pasteurized at suitable time and temperature conditions. The aqueous mix is then cooled and combined with additional ingredients such as heat-

sensitive flavors, fruit purees etc. and passed to a continuous ice cream freezer where the mix is partially frozen and aerated. The freezer produces an ice slurry having an overrun of from 20 to 40% or more, and a temperature of about 10 to 20°F (-12 to -7°C). The slurry is then packaged and hardened at about -20°F (-29°C). This process is distinguished from ice cream manufacture, however, in that no homogenization step is employed.

Specific embodiments of the soft-frozen water-ice products of this invention are given in the following examples:

EXAMPLE 1

A strawberry flavored water-ice was prepared by combining the following ingredients:

Ingredient	Weight %
Water	54.4
Corn syrup solids (36 D.E.)	14.8
Dextrose (monohydrate)	12.0
Strawberry puree (10% solids)	10.0
Sucrose	7.4
Flavor and Color	0.5
Citric Acid	0.4
Stabilizer (40% sodium alginate, 60% carrier)	0.3
Emulsifier (mono and diglycerides)	0.18
Emulsifier (polysorbate 80)	0.03

The ingredients with the exception of the puree, flavors and citric acid were combined and pasteurized at 160°F (71°C) for ten minutes. This mix was then cooled to about 40°F (4°C) and combined with the remaining ingredients.

The mix was processed in a conventional ice cream freezer to a temperature of about 15°F (-9°C) and an overrun of 40% and then packaged in collapsible

containers and frozen at -20°F (-29°C). The product was stored at 0°F (-18°C) where it maintained an extrudable consistency and possessed a smooth texture after six months storage.

EXAMPLE 2

Operating in accordance with Example 1 an orange-flavored water ice was prepared having the following formulation:

Ingredient	Weight %
Water	62.1
Corn syrup solids (36 D.E.)	14.8
Dextrose (monohydrate)	12.0
Sucrose	7.4
Orange juice concentrate 65° Brix	1.6
Orange juice puree (6° Brix)	1.0
Flavor and Color	0.4
Stabilizer (as per Example 1)	0.3
Emulsifier (as per Example 1)	0.21

The product maintained an extrudable consistency and possessed a smooth texture after six months storage at 0°F.

EXAMPLE 3

A fruit-containing, raspberry water-ice product was prepared by combining the listed ingredients to prepare a base formulation having a moisture content of 58.8% by weight.

Ingredient	Weight %
Water	30.23
Corn Syrup Solids	16.04
Dextrose	13.04
Sucrose	8.7
Stabilizer (as per Example 1)	0.22
Emulsifier (as per Example 1)	0.23
Citric Acid	0.27
Color	0.02
Raspberry Puree	4.89
Fruit Juices	23.91
Natural Raspberry Flavor Base	2.45

The first six ingredients were combined, pasteurized and cooled as per Example 1. Thereafter the citric acid, color, puree, fruit juices and flavor base was added. This base formulation was passed through an ice cream freezer from which it exited at 15°F and an overrun of 50%. Infused raspberry pieces (62% solids) were then blended into the soft-frozen base formulation at a level of 8% by weight of the base using an ingredient feeder before the product was packaged and frozen at -20°F. After one-month, storage at 0°F the packaged soft-frozen water ice was both extrudable and smooth textured and comparable to the consistency and texture of Examples 1 and 2 after one month at 0°F. The six-month storage stability of this Example is projected to be comparable to that of Examples 1 and 2.

EXAMPLE 4

A fruit-containing, orange water-ice product having a total moisture content (excluding orange pieces) of 59.0% was prepared as in Example 3 by combining the ingredients listed below to prepare a base formulation and then adding infused mandarin orange pieces (40% solids) to the soft-frozen base at an 8% level.

Ingredient	Weight %
Water	29.75
Corn Syrup Solids	16.04
Dextrose	13.04
Sucrose	8.7
Stabilizer (as per Example 1)	0.22
Emulsifier (as per Example 1)	0.23
Citric Acid	0.22
Flavor and Color	0.17
Orange Cell Sacs	2.17
Fruit Juices	29.46

This soft-frozen orange water-ice product possessed a freezer storage stability comparable to that of Example 3.

Having thus described the invention what is claimed is:

CLAIMS

1. A frozen, aerated fat-free and protein-free dessert product which is extrudable by hand from a collapsible package at temperatures between 0°F and 10°F, said product having a water content of from 50 to 68% by weight, a total carbohydrate content of from 28 to 45% by weight, food acid at up to 1% by weight, chemical emulsifiers at from 0.05 to 0.4% by weight and hydrocolloid stabilizers up to 0.5% by weight.

2. The product of claim 1 wherein the product is free of dairy ingredients.

3. The product of claim 2 wherein the product is fruit flavored.

4. The product of claim 3 wherein the product contains natural fruit solids.

5. The product of claim 1 wherein the chemical emulsifier include at least 0.001% polysorbate 80.

6. The product of claim 1 wherein the chemical emulsifier include at least 0.01% polysorbate 80.

7. The product of claim 4 wherein the product contains fruit juice and fruit puree.

8. The product of claim 7 wherein the product contains fruit pieces.

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(54) Stable aerated frozen food product.

(57) A process for preparing an aerated frozen food product such as mellorine or a shake beverage wherein water, fat, protein, emulsifier and stabilizer are blended together to form a mix which is homogenized to form an oil-in-water emulsion and is subsequently whipped under freezing conditions. Improved stability is achieved in the product by selecting a specific oil having high solid fat content at room temperature, homogenizing the mix of ingredients under conditions sufficient to form an emulsion having a relatively narrow distribution of small diameter fat globules, and aging the emulsion to crystallize the fat globules prior to whipping. Stable aerated frozen products provided in accordance with this invention can be stored and distributed at 0°F without loss of quality and have a variety of commercial uses.

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STABLE AERATED FROZEN FOOD PRODUCT

Frozen aerated food products to which this invention is directed include frozen desserts such as ice cream, ice milk, mellorine, sherbet, frozen custard, frozen pudding and the like, frozen shake beverages such as milk shakes, and frozen shake concentrate. The popularity of these products is attributable to their convenience, widespread availability, nutritive value and appealing forms, colors and flavors. In part due to the familiarity of such frozen products to the consumer, to be acceptable they must not only have suitable flavor and appearance, but also possess a complex set of physical properties which provide the characteristics which consumers have come to expect. In addition, the nature and composition of the most popular aerated frozen products are set by various standards promulgated by the U.S. Food and Drug Administration as well as the individual states. Such rigid consumer acceptance criteria, regulatory standards and the complex nature of the interactions which produce a satisfactory product make it extremely difficult to reformulate such aerated frozen products in an attempt to provide improvements. Solutions to one set of problems quite often generate other problems which make the product unacceptable.

Stability is one major problem of conventional aerated frozen products. For example, ice cream and related aerated frozen desserts are stored, distributed, delivered and sold at deep freeze temperatures, i.e. -20°F, to give some measure of stability to these products and protect against deterioration of their special textural properties. This storage and distribution system, however, has many drawbacks both from the consumer's and manufacturer's point of view. One problem is that, at deep freeze temperatures, the product is so hard that it is difficult to scoop and serve immediately from the deep freeze.

Another major problem is that temperature fluctuations invariably occur during storage and handling of aerated frozen products which result in the thawing and refreezing of the product, seriously deteriorating its quality over time. This "heat shock" is characterized by the formation of large ice crystals, and results in excessive hardening and gritty mouthfeel. Heat shock frequently also produces a separation of the syrupy aqueous phase from the air and fat matrix which ultimately make the appearance and texture of the product unacceptable.

Several solutions to these problems have been attempted in the past. For example, increased stability has been imparted to aerated frozen desserts through the use of various stabilizers and stabilizer combinations. The drawback of this approach is that stabilizers frequently are required in such great quantities that the feel of the product in the mouth is altered, producing a cloying, gummy or greasy sensation. Another approach has been to increase the amount of added sugars relative to the fat and/or water in the product, but the large amount of sugar required to provide acceptable stability often

results in too sweet a taste or unacceptable crystal formation. Still another approach has been to increase the amount of incorporated air, i.e., "overrun", and thereby decrease the amount of freezable water per unit volume. This attempt at reformulation, however, not only results in a texture which is more characteristic of a whipped topping than of a frozen dessert like ice cream, but is limited by the applicable standards of identity relating to required weight per volume and solids content.

As a result of the instability of most aerated frozen desserts, producers have been required to manufacture the products locally to avoid the long periods of storage and temperature variations which are associated with national distribution from a few centrally located plants. Since most producers, distributors and retailers rely on deep freeze temperatures for preserving the quality of ice cream-type desserts during storage, distribution and sale, totally separate systems are rerquired for such products than are used for other frozen foods, which can be distributed at temperatures ranging from 0°F to 10°F. A very extensive network of frozen food storage, distribution and retailing facilities has been established nationwide, and therefore it can be seen that it would be extremely advantageous from an economic and efficiency standpoint if an ice cream-type aerated frozen dessert of acceptable quality and stability could also utilize this system.

Milkshakes and similar frozen shake beverages are representative of another type of aerated frozen food product in which poor stability has limited the storage and distribution systems which the manufacturer can utilize. As is well-known, milkshakes are usually manually prepared or dispensed from a commercial establishment for consumption on the premises. Various

attempts have been made in the past to provide products which are more widely available or are more susceptible to automated procedures. For example, milkshakes have simply been packaged in individual cups and frozen solid for distribution. The product is then warmed under controlled conditions to room temperature, agitated or otherwise mixed, and served. Another approach has been to prepare and distribute a frozen milkshake concentrate which serves as a base to which milk or water is added with agitation. Still another approach has been to aseptically can or bottle a prepared milkshake which is consumed after being chilled, shaken and opened. All of these prior approaches have either required unacceptably large amounts of time or space, required a reconstitutional step which is either difficult or time-consuming and/or have provided milkshakes which do not have the desired creaminess, coldness and consistency of commercially prepared milkshakes.

Since shakes are extremely popular items at fast food restaurants, it is of course important to reduce the time and labor involved in preparing large quantities of shakes manually. The present invention provides stable shakes which can be prepared in individual containers in central locations and shipped in a frozen state to various restaurant locations where they are stored and served at refrigeration temperatures without any on-site preparation.

Accordingly, it is an object of this invention to provide aerated frozen food products which are stable for sufficient periods of time to allow national distribution under conditions and temperatures encountered in 0°F frozen food systems. Another object is to provide an aerated frozen product which attains the aforesaid stability without a basic reformulation which would bring

the product outside the limits of consumer acceptance and regulatory standards. A still further object of the invention is to provide aerated frozen dessert products having the above attributes which are also soft and scoopable at freezer temperatuers. Another object is to provide shakes and similar beverages having the above attributes which retain the desirable characteristics of commercially prepared milkshakes when served at regrigeration temperatures (e.g. 15°F-25°F). A related object is to provide a frozen shake concentrate which can readily be reconstituted by the consumer into a high-quality shake.

In accordance with one aspect of the invention, a process for preparing an aerated frozen food product, wherein water, fat, protein, emulsifier and stabilizer are blended together to form a mix and said mix is homogenized to form an oil-in water emulsion which is subsequently whipped under freezing conditions, comprises:

selecting an edible oil which has an SFI of at least 25 to 70°F;

homogenizing said mix to form an emulsion of fat globules having a particle size wherein the average d_{vs} value is 0.2 to 1.5 microns, and a particle size distribution wherein the ratio of d_{vs} to d_{max} has a quotient in the range from 9 to 14;

aging the homogenized mix to crystallize said fat globules prior to said whipping and freezing; and

substantially retaining said particle size and particle size distribution after said whipping and freezing.

In accordance with the present invention, therefore, the fat component of the aerated frozen food product comprises an edible oil which has a solid fat index (SFI) of at least 25 at 70°F. The mix containing this fat is homogenized to form an emulsion of fat globules having an average volume/surface diameter (d_{vs}) of 0.2 to 1.5 microns, and a ratio of maximum fat globule diameter (d_{max}) to d_{vs} having a quotient of from 9 to 14. The emulsion is subsequently aged to crystallize the fat globules prior to whipping. The vast majority of the fat in the product, i.e. at least 94%, is in the form of fat dispersed in the aqueous phase with only a small amount, i.e. less than 6%, in the form of free or de-emulsified fat. The overrun of the aerated frozen food product is preferably from 50% to 110%.

The stable aerated frozen food products of the invention are extremely versatile and can be given a variety of textures and consistencies by varying the formulation. A preferred embodiment of the invention comprises a stable mellorine product having 52% to 57% water in the form of ice crystals and an aqueous phase, 10% to 15% of the aforementioned edible oil, 4% to 15% non-fat milk solids, and minor but effective amounts of stabilizer and emulsifier. Preferably, the whipping step is sufficient to provide an overrun in the range of 60% to 90% in order to produce mellorine having the textural characteristics and appearance of conventional ice cream. Products having the characteristics of soft-serve ice cream at 0°F may further comprise a freezing point depressant, preferably in the form of added sugars or other soluble solutes.

Ready-to-serve shake beverages having improved stability are also provided in accordance with this invention by increasing the amount of water in the above-

mentioned formulation and lowering the overrun to achieve the desired shake consistency. Preferred shakes of the invention comprise about 63% to 68% water, 3% to 9% of the aforementioned edible oil, and about 50% to 70% overrun. These shake products can be distributed through conventional frozen food systems in solid frozen form and then stored for several days at refrigeration temperatures (15°F to 25°F) before consumption without losing the desirable characteristics of commercially prepared milkshakes. The invention can also be employed to provide a frozen concentrate to which water or other liquids are added at room temperature with stirring to produce shake beverages.

It has quite unexpectedly been found that the selection and processing of the fat component during the preparation of the aforementioned aerated frozen food products are critical elements in achieving the unique stability of this invention. Because of the solid fat index (SFI) and other properties of the fat used, the small dispersed fat globules are substantially all crystallized during the aging step and a signficiant amount of these solid crystals are retained when the product is exposed to room temperature. Without intending to be bound by theory, it is thought that the mobility of the aqueous phase during thawing and refreezing of the product is significantly restricted by these finely distributed fat crystals, thereby resulting in products which develop less iciness and retain overrun better when exposed to heat shock than otherwise could be provided. This property in turn is thought to account in large part for the improved shelf life stability of the present products at typical frozen food temperatures.

Preparation in accordance with this invention results in aerated frozen food products which have sufficient stability to retain their desirable organoleptic properties for at least 50 days, and preferably as long as 180 days, at conditions which are normally encountered in typical 0°F frozen food storage, distribution and retailing systems. As a result, the products may be manufactured in a relatively few plants and distributed nationally and/or internationally using the same facilities as other frozen food items such as frozen vegetables, frozen entrees and frozen pizza. Frozen dessert products of the invention do not require a separate deep freezer in the retail store, and can be sold and/or consumed directly from the frozen food case or home freezer. The shake beverages of the invention can be delivered to the restaurant site frozen solid in individual containers and then stored and dispensed directly from a dispenser having a chamber in which the product has equilibrated to a temperature from 15°F to 25°F. Alternately, shakes can easily be prepared at home from a frozen concentrate of the invention stored in the home freezer. Preferably, 2 or 3 parts of frozen concentrate are diluted at room temperature (65°F to 75°F) with one part of water, or some other suitable liquid such as milk or juice, and then the diluted concentrate is stirred with a spoon to form the shake.

As briefly described above, the oils suitable for use in the practice of this invention have a Solid Fat Index (SFI) at 70°F of at least 25. SFI values are readily determined in accordance with standard analytical procedures using a dilatometer. Although the oil has a significant solid fat content at 70°F, it should be liquid at that temperature or easily liquefiable on warming and be substantially completely melted at about 100°F or slightly above. As used herein and in the claims the term

"oil" is intended to designate liquid fats meeting these requirements. Generally, the preferred oils are hydrogenated vegetable oils which have a (capillary) melting point between 70°F and 106°F, or blends of such vegetable oils. Suitable oils are derived from coconut, soybean, cottonseed, corn, palm kernel, peanut or the like. The solid fat in the most preferred oils melts quickly between 70°F and 100°F and these oils exhibit a sharp peak on a Differential Scanning Calorimetry curve. Since ice cream, ice milk, and milkshake standards require the use of butter fat, it is contemplated that high melting point fractions of butter oil meeting the SFI requirements of the invention could also be used to produce stable ice cream, ice milk, and milkshake products in accordance with this invention.

The amount of the fat component will vary depending on the aerated frozen food product being prepared and the particular organoleptic properties desired. Generally, the amount of the fat component comprises about 3% to 30% by weight of the frozen product, with the preferred mellorine products comprising 5% to 30% fat, most preferably 10% to 15% fat. The most preferred shake products of the invention comprise from 3% to 9% fat.

The fat component of this invention can be mixed with other ingredients at ambient temperatures but is preferably injected at an elevated temperature, e.g. about 160°F, into the aqueous mix containing the other ingredients. The resultant mixture is then homogenized, primarily to reduce the size of the fat globules and form a stable oil-in-water emulsion. In accordance with the preferred embodiment of the invention, the mix is homogenized at a low pressure, i.e., a total pressure below 6000 psig, to provide a uniform distribution of small fat globules in the emulsion.

The designations "d_{vs}" and "d_{max}" used herein and in the appended claims to characterize the particle size of the emulsion are derived from the spectroturbidimetry method described in detail by Walstra [P. Walstra, Estimating Globule-Size Distribution of Oil-in-Water Emulsions by Spectroturbidimetry. J. Coll. Interf. Sci. Vol. 27, No. 3, P. 493-500 (1968); and P. Walstra, Light Scattering by Milk Fat Globules, neth. Milk and Dairy J., Vol. 19, No. 2, P. 93-109 (1965)]. In general, this technique is based on the principle that the turbidity of an emulsion such as milk can be used to determine the average particle size and particle size distribution of the dispersed oil phase. In this method, a light beam is directed through the emulsion and the light scattering coefficient is taken as a function of a dimensionless number derived from the particle size of the suspended fat globules and the wavelength of the light. The transmittance and absorbance of the light beam incident on the emulsion contained in a standard cell is measured for various wavelengths using a spectrophotometer, and then these values are used to construct a light scattering spectrum. Homogenized emulsions typically show a log normal frequency-volume distribution, so a computer is used to generate a theoretical light scattering spectrum based on a log normal particle size distribution. The volume/surface average diameter of the fat globules (herein and in the claims referred to by the designation d_{vs}) and the maximum emulsion diameter (herein and in the claims referred to by the designation d_{max}) are mathematically calculated from the "fit" of the experimentally derived curve to the theoretical curve.

In accordance with the present invention, the mix is homogenized to provide a d_{vs} of 0.2 to 1.5 microns, preferably 0.2 to 0.5 microns, with the ratio of d_{max}/d_{vs} having a quotient of from 9 to 14. As previously stated,

this relatively narrow distribution of small fat globules in combination with the solid fat characteristics of the oil used has been found to be very important in achieving the improved shelf-life characteristics of the present invention.

Homogenizers commonly used in ice cream manufacture may be employed to homogenize the mix. Although homogenizing techniques not utilizing pressure may be used, a homogenization pressure not in excess of a total of 6000 psig is preferred. In fact, one advantage of the present invention is that the desired homogenization can be achieved at pressures lower than that usually employed in conventional ice cream manufacture, e.g. pressures below 3000 psig. Homogenization is preferably accomplished at temperatures of 110°F to 180°F.

The vigorous agitation of the mix during freezing and whipping inevitably results in some destabilization of the fat emulsion in the form of fat "churnout" or "de-emulsification", i.e., a coalescense wherein the fat globule loses its identity as a dispersed entity and forms pools, and/or "clumps" together to form larger particles. In addition, the emulsion prior to whipping may inherently contain some of this "free" fat. The current understanding in the ice cream art is that such physical properties as dryness and stiffness are related to the degree of de-emulsification of the fat. It is believed that too little de-emulsification results in a wetter-appearing and less stiff ice cream, whereas too much de-emulsification may result in a courser texture. In addition, a coating of de-emulsified fat around the air cells tends to improve the foam stability of the product and is considered desirable. However, too much de-emulsified fat in the continuous phase may give a fatty or too creamy sensation to the frozen product.

It has quite surprisingly been found that the products of this invention exhibit considerably less fat de-emulsification, or free fat, than conventional frozen desserts and shake products. In the present products, at least 94% of the total fat is in the emulsified form and less than 6% of the total fat is in the de-emulsified form, whereas conventional ice cream, for example, typically has about 13% of the total fat in the de-emulsified form. The relatively narrow distribution of small fat crystals produced as a result of the homogenization and aging steps of the invention is substantially retained after the freezing and aeration step and this in turn is believed to contribute to this low incidence of de-emulsified fat.

De-emulsified fat can be extracted by hydrophobic organic solvents such as chloroform because of its "free" character, whereas emulsified fat cannot. Therefore, the level of de-emulsified fat in the frozen product can readily be determined by mixing a sample with chloroform, removing the chloroform soluble fraction, evaporating the chloroform and weighing the residue. De-emulsified fat so determined is then expressed as a percentage of the total fat.

The fat component of the invention may be used with mono and diglyceride emulsifiers and other emulsifiers normally used in aerated frozen food products and/or permitted by the applicable standards of identity. Such emulsifiers are typically used in amounts ranging from 0.1% to 0.5%, preferably less than 0.3%. The emulsifiers may be conveniently melted with the fat component and metered together into the mix prior to homogenization.

The mix may be pasteurized before or after homogenization in accordance with known commercial procedures. For example, continuous high temperature/short time (HTST) pasteurization is the most common method used by the larger ice cream plants and is suitable for the practice of the present invention. Minimum pasteurization standards for ice cream mix recommended by the U.S. Public Health Service are 175°F for 25 seconds for the HTST method, and 155°F for 30 minutes for the alternative holding method.

Following homogenization and pasteurization, the mix is rapidly cooled and held ("aged") at 30°F to 45°F for a time sufficient to cause extensive crystallization of the fat globules, usually from 2 to 12 hours. It is believed that the resultant distribution of small fat crystals which retain a significant amount of solid fat at room temperature not only aids in the freeze-thaw stability of the product by providing physical barriers limiting the mobility of the aqueous phase, but also contributes to improved physical properties of the frozen product, such as a smoother texture.

After sufficient aging, the mix is simultaneously aerated ("whipped") and frozen in the conventional manner. In a continuous freezer, the mix is rapidly cooled to freezing temperature and air is simultaneously incorporated to form the basic foam structure of small uniformly dispersed air cells. These processes take place under conditions of vigorous agitation provided by a "mutator", a rotating cylindrical device equipped with scraper blades and a whipping mechanism. The residence time during freezing is usually on the order of 25 to 30 seconds. As freezing proceeds, the mass becomes increasingly viscous and is finally extruded into containers from the freezer in a stiff plastic condition.

The product may then be further frozen (hardened) at a temperature of about -40°F to -80°F prior to storage at typical frozen conditions.

The amount of incorporated air, i.e., the "overrun", is important to the overall stability of aerated frozen products, yet must be controlled within certain limits to provide an acceptable texture and appearance. Generally, the higher the overrun, the lower the amount of water per unit of volume, and therefore the more resistant the product is to the formation of the large ice crystals after heat shock. Although high overrun aerated frozen products exhibit increased stability, increasing the overrun to improve the stability will not always produce an acceptable product since there are limits placed on the amount of air incorporated in the product, both by the various standards of identity and consumer preference. For example, federal regulations on solids content and weight/volume relationships for ice cream and related products, such as mellorine and ice milk, effectively limit the overrun to about 110%. Frozen desserts having overruns in excess of this amount tend to exhibit textural properties which are not characteristic of ice cream, and therefore are not preferred by consumers. The practice of the present invention is particularly advantageous for stabilizing ice cream-type frozen desserts without requiring overruns over 110%. Although products of this invention generally comprise less water than conventional ice cream-type products, they have similar overrun so as to retain the familiar textural properties of ice cream. Preferably, the frozen mellorine desserts and shake concentrates described herein comprise from 45% to 68% water, with 52% to 57% water being the most preferred range. Overrun for these products is usually from 50% to 110%, preferably about 60% to 90%.

There are no existing standards which dictate the amount of overrun in milkshakes and similar frozen shake produts. However, such products usually become too foamy to be acceptable at overruns of 80% or over, and too liquid or thin at overruns of 30% or below. For the ready-to-serve frozen shakes of this invention, the preferred water content is 63% to 68% and the preferred overrun is about 50% to 70%.

A stable foam (aerated) phase imparts a structural rigidity to the subject frozen food products and aids in limiting the mobility of the aqueous phase which causes the separation of the phases during prolonged storage. To this end, foam stabilizers are useful in the practice of the present invention. Among the most useful stabilizers are the hydrophilic colloids, or hydrocolloids, commonly referred to as "gums". These long-chain high-molecular-weight polymers disperse in the aqueous phase and/or interact with other product ingredients to provide a thickning or gelling effect which stabilizes the foam structure. They also contribute to the stability of the product by serving as water-binding ingredients which limit the mobility of the aqueous phase. Common gums suitable for use in the present invention include natural gums such as carrageenan, guar gum, locust bean gum, xanthan gum, gelatin, alginates, pectin, dextran, glucan and the like, as well as modified natural gums such as carboxymethyl cellulose, methylcellulose ether and other modified cellulose derivatives, modified starch, polyacrylic acid, and the like, and various mixtures thereof. The permitted quantities of gums may be governed by federal and/or state regulations, as well as by consumer preference regarding such physical properties as mouth feel and melt-down rate. The unique stability characteristics of the products of this invention allow

very small amounts of stabilizers to be used, preferably quantities much less than 1% and most preferably less than 0.3%.

Aerated frozen dessert products of the invention may be given hardness and texture at 0°F which simulate that of commercially available soft-serve ice cream. Conventional soft-serve ice cream products are usually prepared using machinery located on the premises where they are consumed and are served at temperatures slightly below freezing, e.g., 15°-25°F. Accordingly, these products characteristically have poor keeping qualities which prevent their effective distribution and storage off premises. If exposed to the deep freeze temperatures necessary to prolong their shelf life, conventional soft-serve products become very hard and cannot be scooped from a container for serving. To solve this problem, aerated frozen dessert products sometimes include greater than normal quantities of sugars, alcohols and other low molecular weight compounds to lower the freezing point of the aqueous phase to an extent where the product is soft and scoopable and has a soft-serve texture at freezer temperatures. Frozen shake concentrates are also made more easily dispersible by the addition of such compounds. It has been found that the use of such freezing point depressants is compatible with he practice of the present invention and that the unique stability of the products can readily be achieved with formulations including such compounds.

The most useful freezing point depressants in the practice of this invention are sugars which not only have a sweetening effect, but also enhance the creamy texture of the product. The choice of sugars employed is controlled by the degree of freezing point depression desired and also by flavor and texture effects resulting

from the addition of such sugars. An insufficient amount of sugar will produce an off-taste in the product, whereas too much sugar will produce excessive sweetness and may mask other desirable flavors. Different sugars also lower the freezing point of the product to varying degrees, depending on their molecular weights.

Preferably, the amount of added sugars in the products of this invention is 18% to 33% by weight. It has been found that the most desirable balance of sweetness and textural properties may be achieved by employing sucrose in combination with one or more sugars which are less sweet; for example, sucrose may be combined with dextrose, lactose, low-conversion corn syrup, etc; in order to obtain the benefits of a relatively large proportion of sugar at a level of sweetness which is less than that resulting from the use of an equal amount of sucrose alone.

The products of this invention comprise 4% to 15% non-fat milk solids. Although non-fat milk solids are the preferred source of protein, it is contemplated that other suitable frozen dessert proteins, such as casein, caseinates, whey protein concentrate, egg protein, and soy, peanut and/or vegetable proteins may be used. Non-fat milk solids are the solids of skim milk and can be added in dry form or as condensed skim milk. These solids include proteins, minerals and milk sugar. Milk sugar adds to the sweet taste of the frozen product and proteins aid in the development of the desired overrun as well as contribute to the desirable texture and body of the product. The use of larger amounts of non-fat milk solids increases the effect that whipping has on the frozen product and increases the viscosity and resistance to melting of the composition. They also tend to lower the freezing point of the product. Non-fact milk solids which

contain not less than 2.5 mg/g undenatured whey protein nitrogen per gram of milk solids, as determined by the procedure set forth in American Dry Milk Institute Bulletin 916, are preferred.

The following examples are intended to illustrate the present invention, and are not to be construed as limiting the invention in any way:

Example I

A series of six frozen aerated desserts were prepared containing the following ingredients in parts by weight:

	Parts/Weight
Non-fat Dry Milk Solids	6.60
Fat Component	12.00
Dextrose	21.2
Sucrose	4.10
Corn Syrup	2.40
Xanthan Gum	0.264
Carrageenan	0.004
Emulsifier	0.10
Flavoring	0.40
Coloring	0.84
Water	52.10

The samples were made according to the following procedure:

48 pounds of the fat component was melted with 0.4 pounds of the emulsifier component by heating to a temperature of 110°F in a 70 gal. jacketed container to form the fat phase. 26.4 pounds of non-fat dry milk solids was dispersed in 206 pounds of water and the

remaining ingredients (122 pounds) were added to form the aqueous phase. The fat and aqueous phases were mixed together at 160°F, homogenized at a pressure of 1500 psi, and the emulsion thus formed was pasteurized at 175°F for 25 seconds. The mix was then cooled to between 30°F and 40°F and aged for 12 hours at 40°F. The aged mix was aerated in an ice cream freezer at about 16°F to provide an overrun of about 75%, extruded into suitable containers, hardened at a temperature of -40°F to -80°F and stored in a 0°F freezer.

The SFI values of the fat components employed in the six samples were as follows:

Sample SFI at 100°F	Fat Component	SFI at 70°F
A	Coconut Oil	46.10
B	Coconut Oil	37.40
C	Coconut Oil	26.60
D	Soy/Coconut Oil Blend	20.00
E	Soybean Oil	16.90
F	Anhydrous Butter	13.80

The average fat particle size (d_{vs}) of each sample was from 0.2 to 0.5 microns, and the d_{max}/d_{vs} quotient was in the range from 9 to 14. The amount of free fat for each sample was 2% to 3% using the chloroform extraction method.

The samples were subjected to conditions which were representative of those encountered in a typical 0°F distribution system. Samples in their containers on a "mock" pallet were removed from the 0°F freezer, kept for

2-4 hours at room temperature (about 70°F), and then placed back in the 0°F freezer for 20-22 hours. This procedure was repeated 4 or 5 times.

After undergoing the above freeze-thaw cycles, the samples were submitted to test panels consisting of 10 to 15 people, who were asked to rate them for iciness and softness. Samples A, B, and C incorporaing the present invention were judged by the panels to be acceptable, whereas the remaining samples not incorporating the invention were determined to be unacceptable.

Example II

A Sample G employing the coconut oil of Sample B was prepared and subjected to heat shock in accordance with the procedure described in Example I, except that Sample G was prepared in a low shear device (i.e. an Oakes mixer) to provide an average particle size (d_{vs}) of 6.4 microns and a ratio of d_{max} to d_{vs} having a quotient of 2.0. Sample G was considered to be unacceptably unstable to heat shock and was judged to be icy and coarse by the evaluation panel.

Example III

A frozen shake product was prepared using the procedure of Example I and the following formula:

	Parts/Weight
Non-fat Dry Milk Solids	10.000
Coconut Oil	5.715
Dextrose	14.000
Sucrose	6.000
Xanthan Gum	0.175
Carrageenan	0.060
Emulsifier	0.100
Flavoring	0.400
Coloring	0.400
Water	63.150
Overrun	60%

This product (Sample H) was extruded into a 14 fl. oz. waxed paper cup and placed in a 20°F refrigerator along with a prior art frozen shake (Sample I) made in accordance with Arbuckle U.S. Pat. No. 3,479,187. Samples H and I were taken from the refrigerator, and along with Sample J, a typical fast food restaurant shake, they were allowed to sit at room temperature (72.4°F) for 40 minutes. Both Sample I and J exhibited symptoms of instability after this time. Sample J developed a phase separation band about 2 cm wide at the bottom, and large (about 0.3 cm diameter) air bubbles on the top to give a very foamy appearance. Sample I developed a rim of fluid around an unappealing icy lump in the center of the shake. However, there were no significant changes observed in Sample H, during this time period, thereby demonstrating the superior stability of the shake beverages of the present invention when compared to prior art products.

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CLAIMS:

1. A process for preparing an aerated frozen food product, wherein water, fat, protein, emulsifier and stabilizer are blended together to form a mix and said mix is homogenized to form an oil-in-water emulsion which is subsequently whipped under freezing conditions, characterized in that it comprises:

selecting an edible oil which has an SFI of at least 25 at 70°F;

homogenizing said mix to form an emulsion of fat globules having a particle size wherein the average d_{vs} value is 0.2 to 1.5 microns, and a particle size distribution wherein the ratio of d_{vs} to d_{max} has a quotient in the range from 9 to 14;

aging the homogenized mix to crystallize the fat globules prior to the whipping and freezing; and

substantially retaining the particle size and particle size distribution after the whipping and freezing.

2. A process as defined in claim 1, characterized in that the mix is homogenized at a pressure less than 6000 psig.

3. A process as defined in claim 1 or claim 2 characterized in that the homogenized mix is aged at 30°F to 45°F for 2 to 12 hours prior to whipping and freezing.

4. A process as defined in any one of claims 1 to 3, characterized in that the aged mix is whipped to an overrun of 50% to 110% to provide a frozen dessert product.

5. A process as defined in any one of claims 1 to 3, characterized in that the aged mix is whipped to an overrun of about 50% to 70% to provide a frozen shake product.

6. A process for preparing a stable aerated frozen dessert product, characterized in that the process comprises the steps of:

mixing 45% to 68% water, 3% to 30% edible oil having an SFI of at least 25 to 70°F, 4% to 15% non-fat milk solids, and minor but effective amounts of stabilizer and emulsifier to form a mix;

homogenizing said mix to form an emulsion of fat globules having a particle size wherein the average d_{vs} value is 0.2 to 1.5 microns and a particle size distribution wherein the ratio of d_{vs} value is 0.2 to 1.5 microns and a particle size distribution wherein the ratio of d_{vs} to d_{max} has a quotient of from 9 to 14;

aging the homogenized mix at 30°F to 45°F for 2 to 12 hours to crystallize said fat globules;

whipping the aged mix under freezing conditions to an overrun of 50% to 110%; and

substantially retaining said particle size and particle size distribution after said whipping and freezing.

7. A process as defined in claim 6, characterized in that the oil and emulsifier are melted together and injected just prior to homogenization into a solution of the remaining ingredients in the water.

8. A process as defined in claim 6, characterized in that the aerated frozen dessert is hardened at -40°F to -80°F after whipping.

9. A process as defined in claim 8, characterized in that the hardened aerated frozen dessert is stored, distributed, sold and consumed at 0°F to 10°F.

10. A process as defined in claim 8, characterized in that 2 to 3 parts of the aerated frozen dessert are diluted at room temperature with one part of liquid and stirred to form a shake beverage.

11. A process for preparing a stable shake beverage, characterized in that the process comprises:

mixing 63% to 68% water, 3% to 9% edible oil having an SFI of at least 25 to 70°F, 4% to 15% non-fat milk solids, and minor but effective amounts of stabilizer and emulsifier to form a mix;

homogenizing said mix to form an emulsion of fat globules having a particle size wherein the average d_{vs} value is 0.2 to 1.5 microns and a particle size distribution wherein the ratio of d_{max} to d_{vs} has a quotient of from 9 to 14;

aging the homogenized mix at 30°F to 45°F for 2 to 12 hours to crystallize said fat globules;

whipping the aged mix under freezing conditions to an overrun of 50% to 70%;

substantially retaining said particle size and particle size distribution after said whipping and freezing;

placing the aerated frozen product into individual containers; and

allowing said aerated frozen product to equilibriate to a temperature of from 15°F to 25°F until it develops a shake consistency.

12. A process as defined in claim 11, characterized in that the aerated frozen product is hardened at -40°F to -80°F after it is placed into individual containers.

13. A stable aerated frozen food product characterized in that it is formed by a process which comprises the steps of:

mixing 45% to 68% water, 3% to 30% edible oil having an SFI of at least 25 to 70°F, 4% to 15% non-fat milk solids, and minor but effective amounts of stabilizer and emulsifier to form a mix;

homogenizing said mix to form an emulsion of fat globules having a particle size wherein the average d_{vs} value is 0.2 to 1.5 microns and a particle size distribution wherein the ratio d_{vs} to d_{max} has a quotient of from 9 to 14;

aging the homogenized mix at 30°F to 45°F for 2 to 12 hours to crystallize said fat globules;

whipping the aged mix under freezing conditions to an overrun of 50% to 110%; and

substantially retaining said particle size and particle size distribution after said whipping and freezing.

14. A stable ready to serve shake beverage, characterized in that it is formed by a process which comprises:

mixing 63% to 68% water, 3% to 9% edible oil having an SFI of at least 25 to 70°F, 4% to 15% non-fat milk solids, and minor but effective amounts of stabilizer and emulsifier to form a mix;

homogenizing said mix to form an emulsion of fat globules having a particle size wherein the average d_{vs} value is 0.2 to 1.5 microns and a particle size distribution wherein the ratio of d_{max} to d_{vs} has a quotient of from 9 to 14;

aging the homogenized mix at 30°F to 45°F for 2 to 12 hours to crystallize said fat globules;

whipping the aged mix under freezing conditions to an overrun of 50% to 70%;

substantially retaining said particle size and particle size distribution after said whipping and freezing;

placing the aerated frozen product into individual containers; and

allowing said aerated frozen product to equilibriate to a temperature of from 15°F to 25°F until it develops a shake consistency.

15. A product as defined in claim 14, characterized in that it has an overrun of 50% to 110%.

16. A product as defined in claim 14 or claim 15, characterized in that at least 94% of said oil is dispersed in said aqueous phase in the form of said crystallized fat particles and less than 6% of said oil is in the form of de-emulsified fat.

17. A food product whenever formed by the process as claimed in any one of claims 1 to 12.

18. A stable aerated frozen food product, characterized in that it comprises:

45% to 68% water in the form of ice crystals and an aqueous phase;

4% to 15% non-fat milk solids;

3% to 30% edible oil having an SFI of at least 25 at 70°F, a majority of said oil being dispersed in said aqueous phase in the form of crystallized fat particles having a d_{vs} value of 0.2 to 1.5 microns and a ratio of d_{max} to d_{vs} having a quotient of from 9 to 14; and

minor, but effective, amounts of emulsifer and stabilizer.

19. A product as defined in claim 18, characterized in that it has an overrun of 50% to 110%.

20. A product as defined in claim 18, characterized in that at least 94% of said oil is dispersedin said aqueous phase in the form of said crystallized fat particles and less than 6% of said oil is in the form of de-emulsified fat.

21. A product as defined in claim 18, characterized in that it further comprises a hydrocolloid stabilizer system in a quntity less than 1%.

22. A product as defined in claim 18, characterized in that it comprises 0.1% to 0.5% emulsifier.

23. A stable frozen mellorine product, characterized in that it comprises:

52% to 57% water in the form of ice crystals and an aqueous phase;

4% to 15% non-fat milk solids;

10% to 15% edible oil having an SFI of at least 25 at 70°F, at least 94% of said oil being dispersed in said aqueous phase in the form of crystallized fat particles having a d_{vs} value of 0.2 to 0.5 microns and a ratio of d_{max} to d_{vs} having a quotient of from 9 to 14, and less than 6% of said oil in the form of de-emulsified fat;

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18% to 33% added sugars; and

an overrun of 60% to 90%.

24. A stable ready-to-serve shake beverage characterized in that it comprises:

63% to 68% water in the form of ice crystals and an aqueous phase:

4% to 15% non-fat milk solids;

3% to 9% edible oil having an SFI of at least 25 at 70°F, at least 94% of said oil being dispersed in said aqueous phase in the form of crystallized fat particles having a d_{vs} value of 0.2 to 1.5 microns and a ratio of d_{max} to d_{vs} having aquotient of from 9 to 14, and less than 6% of said oil in the form of de-emulsified fat;

18% to 33% added sugars;

0.1% to 0.3% mono- and/or di-glyceride emulsifiers;

less than 0.3% of a hydrocolloid stabilizer; and

an overrun of 50% to 70%.

European Patent Office

EUROPEAN SEARCH REPORT

0147483
Application number

EP 83 11 3183

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	US-A-3 914 440 (RALPH P. WITZIG) * Column 2, lines 5-14; column 3, line 61 - column 4, line 3 * ---	1,2,6, 9,17	A 23 G 9/02 A 23 G 9/04
Y	US-A-4 421 778 (MARVIN L. KAHN et al.) * Column 3, lines 25-27; column 5, lines 25-30; claims 1,25 * ---	1,2-6, 9,10, 17	
Y	GB-A-2 045 050 (D. TRESSER) * Page 3, lines 50-60; page 2, lines 20-27 * ---	1,2,4-6,17	
Y	US-A-4 368 211 (J.R. BLAKE et al.) * Column 7, lines 20-25; examples 1-3; column 8, lines 30-41 * ---	1-10, 17	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) A 23 G
Y	MILK PLANT MONTHLY, June 1948, pages 42-50; L.L. LITTLE: "Emulsifying and stabilizing agents for ice cream" * Page 44, column 2, paragraph 2; page 50, column 2, paragraph 4 * --- -/-	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27-07-1984	GUYON R.H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
P : intermediate document
T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

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EUROPEAN SEARCH REPORT

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Application number

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Page 2

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Y	US-A-4 031 261 (J.R. DURST) * Examples 1-13; column 3, lines 14-24; claim 15; column 12, lines 30-35; column 6, lines 50-68 *	1,9,10,17	
A	US-A-3 431 117 (G.J. LORANT) * Column 2, lines 34-37; column 3, lines 45-50; column 3, lines 15-17; claims 1-8 *	1	
A	US-A-3 889 001 (N.F. BUIDE et al.)		
A	FR-A- 868 427 (SOC. ASTRA) * Abstract no. 1a *	7	
A	US-A-4 346 120 (R.C. MORLEY et al.)		TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
A	US-A-3 949 102 (J.A. HELLYER et al.)		
E,X	US-A-4 434 186 (NITIN DESIA et al.)	1-24	
A	US-A-3 993 793 (D.J. FINNEY)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27-07-1984	GUYON R.H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

PATENT SPECIFICATION

NO DRAWINGS

1,196,286

Date of Application and filing Complete Specification: 23 June, 1967.
No. 29163/67.
Application made in United States of America (No. 560260) on 27 June, 1966.
Application made in United States of America (No. 589225) on 25 Oct. 1966.
Complete Specification Published: 24 June, 1970.

Index at acceptance: —**A2 B16; C4 X11**

International Classification: —**A 23 g 5/00**

1,196,286

COMPLETE SPECIFICATION

Foodmix

I, DAVID WEINSTEIN, of 6411, Laurel Drive, Baltimore, Maryland, United States of America, a citizen of the United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed to be particularly described in and by the following statement: —

The present invention relates to an improved method and means for the instantaneous preparation, particularly in the home but also institutionally or for on-location consumers, of a soft form-retaining mass of a whipped aqueous ice cream, ice milk or sherbet mix. In particular the invention provides confectionary food packages in which the components of novel ice cream, ice milk or sherbet mixes are contained under the pressure of a gaseous propellant which is partially dissolved in the mix. When required for use the mix is discharged from the container by the pressure of the gas and is at the same time whipped by the latter so as to form an expanded mass, which can then be frozen to form an ice cream, ice milk or sherbet type of product, by which is meant a product which is outwardly very similar to the usual commercially available ice cream, ice milk or sherbet products in spite of the high degree of expansion or overrun which is used.

By "overrun" there is meant the percentage increase in volume over that of the aqueous mix. When applying the invention this may be at least twice the usual overrun which has been obtained in the past; in the case of ice cream and ice milk, an overrun of at least 160% or, better still, 200% or even higher is preferred. The whipped mixes and the products obtained on freezing then have a body, texture and general palatability which can be at least equal to those of conventionally prepared ice creams, ice milks and sherbets, despite their increased volume and lower specific weight.

By applying the invention, the above mentioned aqueous mixes are caused to be whipped by the gas or gases dissolved therein, when they are discharged from pressurized containers in which the mixes are packaged. A heretofore unattained high overrun for ice cream, ice milk and sherbet products is possible, accompanied by stability at room temperature and on freezing, by a satisfactorily firm body in contrast to the fluffy and foamy products heretofore obtained on high overruns, and by feel, flavour, taste and general palatability which are comparable to those of a superior grade of ice cream, ice milk or sherbet as conventionally prepared. In this way there are obtained, instantaneously, soft confections in a most convenient, expeditious and economical manner and which, on freezing, yield products having a desirably firm body combined with smoothness of texture, in the case of ice cream and ice milk, and pleasing feel, flavour and chewability together with a reduced caloric content per unit volume, the products being at the same time free from defects which are commonly encountered in the standard ice creams, ice milks and sherbets, and which would reasonably be expected in an even greater degree from the nature of the compositions of the invention and their departures from known mixes.

The invention will first be described in connection with the preparation and properties of ice cream mixes and their packaging in pressurized containers and conversion into whipped soft and frozen confections; variation required for ice milk and sherbet mixes will be described later.

An icecream mix must satisfy a large number of requirements to gain consumer favour and to meet legal standards, and it represents a complex mixture of various components whose nature and proportions are so selected as to impart certain desirable qualities

[P[illegible]]

and avoid various possible defects in the frozen product; to the end, a proper balance must be maintained among the various components.

Also, one of the most important limitations that ice cream manufacturers must observe is the total solids content of the aqueous mix, which is usually 36% to 39% and rarely is 1% or 2% higher. Thus, as pointed out on page 31 of Frandsen and Arbuckle, "ICE CREAM AND RELATED PRODUCTS", The Avi Publishing Company, Inc., Westport, Connecticut 1961, "A heavy, soggy product results when the total solids content is too high, usually when above 40 to 42 per cent".

The present invention is based on the conception that it would be desirable to provide simple and economical means for preparing a frozen confection, especially in the home, that has all of the properties of a superior grade of ice cream, but is whipped to a heretofore unattained overrun, preferably 200% and above (i.e., three or more times the volume of the original aqueous mix), so that the whipped and ultimately the frozen confection contain a considerably lower weight of total solids per unit volume than standard ice creams. Thereby a product of lower cost per unit volume is obtained and at the same time, one that meets the needs of "weight watchers", to whom a serving of an ice cream product of a volume equal to a serving of standard ice cream, but having a much lower caloric content, will greatly appeal.

However, a useful higher overrun cannot be attained by simply increasing the whipped-up volume of standard mixes, for then a fluffy, snow-like, unpalatable product is obtained. Prior teachings are to the effect that difficulties will be encountered if it is attempted to increase the content of various components of standard formulations in the effort to obtain a satisfactory product at higher overruns. Thus the skim milk solids content must not be increased, for that would increase the tendency to lactose crystallization, which produces "sandiness". In fact, so serious is the problem of sandiness caused by crystallization of lactose, that it has led to the use of delactosed milk solids-not-fat (skim milk solids). In addition, the cane sugar content must be maintained within certain limits, not only to avoid excessive sweetness, but also because the sugar depresses the freezing point, and thus makes freezing more difficult.

Also, in the replacement of a part of the sucrose in ice cream mixes with corn syrup solids, Frandsen & Arbuckle, *supra*, recommend (page 50 that such solids be limited to from one-fourth to one-third of the sugar content. Prior art teachings are clearly to the effect that the overrun must be limited to a value below 100%; and that only rarely can it be allowed to go slightly above this figure.

It is also known that the higher the total solids content of the mix, the lower is the degree of whipping that can be obtained by the heretofore usual methods of whipping ice cream mixes, so that it would be exceedingly difficult, if not impossible, to obtain an overrun of the order of 200% with increase of the total solids content to make up for the desired volume increase by the procedures heretofore employed, as by mechanical whipping.

It is further known that if the heretofore produced soft ice cream is frozen in a home freezer, especially if it has been exposed to room temperature even for a short time, it becomes sticky and gummy, and also very hard, so that it no longer has the character of ice cream. This occurs also if frozen ice cream is allowed to stand at room temperature, so that it partially melts, and is then re-frozen.

Another consideration that cautioned against increase of the solids content was the fact that increase of the solids content necessarily reduces the water content, so that the concentration of the sugar would be increased thereby. This would result in a lowering of the freezing point and make freezing more difficult. Yet despite such lowering of the water content, the intermediate (soft) products of my present invention can be frozen at the temperature of the home freezer and do not require the lower temperatures used commercially.

I have found that a number of prior practices and precautions must be violated and the mixes unbalanced to produce novel ice cream mixes which, on whipping by a gas or gases dissolved therein and on discharge from a pressurized container, yield products of most pleasing character, and which can be termed an "instant ice cream" (or "instant" ice milk or sherbet). These products, despite a greatly reduced specific gravity, i.e., a low weight per gallon or litre, nevertheless, both in the chilled intermediate state and on freezing, have a most desirable body, texture, feel, taste and other essential properties of a superior ice cream-like confection and are remarkably free from the defects and disadvantages which would be predictable from prior knowledge and experience.

I have discovered that, despite increase of the solids content of ice cream mixes in accordance with the invention, a far higher overrun (160% to above 250%) can be obtained by dispensing from a pressurized container having therein a soluble gas, than by the commonly employed commercial methods of whipping; that despite increase of the skim milk solids (and hence of lactose), in the ice cream and ice milk mixes and even on an

addition of lactose to the mix, but for reasons not yet fully understood, the whipping action of the expanded dissolved gases prevents the expected crystallization of lactose (the cause of sandiness); that despite increase of corn syrup solids, the texture and body of the expanded mix have proved to be highly satisfactory and the whipping is not interfered with; that despite increase of the content of sweetening agents, sugar crystallization does not occur and moderate freezing temperatures are adequate; and that despite a much lower proportionate increase in the total solids content than the degree of overrun, a soft mass is obtained on discharge from the pressurized container which has a body comparing favorably with that of the known soft ice creams, in spite of the latter's much larger content of solids per unit of volume, and which has a firmness superior to that of the known soft ice cream. In fact, the added lactose has been found not only not to crystallize, but to contribute to the retarding of the melting of the soft and frozen products.

Pursuant to the invention, intermediate soft confections of a unique combination of properties are obtained on discharge from an aerosol container at an overrun of 160% to 250% for ice cream and ice milk mixes and 80% to 140% for sherbet mixes (as contrasted with the commercially obtainable overruns for ice cream, ice milk and sherbet mixes of respectively, about 60% to 100%, 40% to 80%, and 30% to 50%). The soft ice cream and ice milk products have an extremely smooth, mousse-like texture, combined with pleasing taste and feel and a firm, shape-retaining body, even though the increase in solids content is only about 10% to 25% over standard mixes, far less than the increase in volume.

The intermediate soft products, especially when discharged from a chilled container, can be eaten as such. They melt only very slowly, and even after standing at room temperature for an hour or more, they retain their volume and shape and do not show any separation of liquid (i.e., there is no "bleeding"). The whipped-up masses accordingly afford the housewife many opportunities for exercising her ingenity to produce unusually flavoured and enriched semi-frozen and frozen confections, which cannot be done with partially melted (and thereby softened) frozen conventional ice creams and ice milks, or with soft ice creams, because these, on re-freezing, become sticky and gummy. The intermediates of the present invention, on the other hand, are discharged from the pressurized container (chilled or not) at a uniform consistency and temperature, do not melt readily, and can be mixed with different flavours and fillings, such as roasted coffee bean or instant coffee powder, powdered cinnamon, fresh, dried or glacé fruits, and nuts; the mixture is then frozen in the home freezer. Successive portions of the whipped mix can be differently treated, so that the same pressurized container can be used to yield different frozen confections. This can be done also in institutions and in restaurants for immediate use or for immediate freezing.

Even in the unfrozen condition, and despite its reduced weight per unit volume, the soft intermediate product is characterized by satisfactory body and a pleasing feel and taste; when frozen, it is comparable to a high grade ice cream. When dispensed from a chilled container, it provides an instant soft ice cream and is the only product of this type which can be prepared in the home without a great deal of labour and mechanical equipment. Even after standing at room temperature for some time, it can, unlike conventional ice cream, be frozen from the soft condition without the appearance of crystallization, gumminess or stickiness. The smoothness of texture is retained even after freezing, there being no ice or sugar crystals in the frozen product, which acquires a degree of stiffness, has a pleasing chewability, and is of highly palatable quality.

The stream of whipped ice cream can be used, as it emerges from the nozzle of the, preferably chilled, pressurized container, as topping for fruits, cakes, pancakes, waffles, crepes, conventional ice cream sundaes, as well as other prepared food dishes, and it is superior to whipped cream when used in coffee. In these uses, it is desirable to avoid too large a proportion of corn syrup solids. In the absence of heat, the chilled topping retains its shape for as much as 1½ hours at room temperature and, in contrast to whipped cream, it can be partially or completely frozen to yield tasteful and palatable confections. The unfrozen mousse-like confection discharged from the pressurized container also provides an interesting, as well as tasty and nutritious, food for infants and children to whom frozen products are preferably not given; for them the confections are desirably made with sterilized mixes.

Whereas commercial ice cream must be frozen at a temperature at least as low as −10°F (−23.3°C) and usually at −20°F (−28.9°C.) the whipped intermediate products of the present invention can be frozen to a satisfactory hardness in the freezer compartment of a household refrigerator, which is usually at a temperature of about 0° to 5°F. (−17.8° to −15.0°C).

In my improved compositions, corn syrup solids may be employed to replace part of the sucrose to an extent as high as 40% or more. These solids contribute to the body and chewability of the frozen confection and cause no difficulty in the whipping by expansion of dissolved (or suspended) gas.

A small amount of either sodium caseinate

or of an edible calcium salt of low solubility, or both, are preferably employed in the mixes, especially the ice cream and ice milk mixes, as they add to the stiffness and body of the product. Among the calcium salts that may be used are the lactate, gluconate, citrate and sulphate.

My improved mixes, even though they contain only about a 10% to 25% increase in solids content over conventional formulations, nevertheless yield an expanded mass of satisfactory body and of a delicious feel and flavour, despite an increase in volume of at least twice that of prior methods of whipping and even 3 or more times the volume of the aqueous ice cream or ice milk mix.

When the contents are pasteurized, the pressurized container can be stored at room temperature for a considerable period, and in the refrigerator for about 6 months; when sterilized, the contents remain fresh indefinitely.

What has been said hereinabove with regard to ice cream applies in general also to ice milk, which differs from ice cream principally in a lower fat content. In sherbet mixes, there must be provided the minimum acid requirement of 0.35% calculated as citric acid. The sugar and stabilizer contents can be adjusted to produce the texture and consistency characteristic of the known sherbets.

Although the examples hereinbelow employ heavy cream (butterfat) as the source of fat, it will be understood that other animal fat or vegetable fat can be used in place of all or part of the heavy cream.

It will be seen from the foregoing that the invention provides for the use of a pressurized container which is only a fraction of the volume of the whipped-up product obtained from it. It enables a householder to prepare instantly and easily a fresh quantity of the desired amount of soft confection, which can then be quickly frozen. This affords the additional advantage that the demand on the capacity of the freezer is reduced.

The maximum solids content that has heretofore been considered possible or practical in commercial ice cream manufacture has been 36.5% for a 10% fat content and 42% for a 16% fat content (all percentages herein are by weight), the latter values giving a rather heavy and soggy product. The usual compositions for commercial ice creams are within the following ranges: Butterfat, 10% to 16%; Skim Milk Solids, 8% to 11%; Sugar, 13% to 17%; Stabilizer, 0.25% to 0.5%; and Emulsifier, 0.25% to 0.5%.

The usual compositions for Ice Milk contain the following: Butterfat, 2% to 7%; Skim Milk Solids, 10% to 13%; Sweetening Agents, 14% to 17%, the total solids content being 29% to 37%.

Sherbets usually have the following composition: Butterfat, 2%; Skim Milk Solids, about 5%; and Sugar, 25% to 35%. The total solids content amounts to 32% to 42%.

In accordance with the invention, the total solids content has been increased for ice cream mix to a value in the range from 43% to 54%. For Ice Milk the value is from 37% to 47%; and for sherbets it is from 42% to 59%.

Formulations exemplifying the present invention may include the following components: For ice cream mix: Butterfat, 10% to 16%; skim milk solids, 11% to 17%, sweetening agent, 17% to 25%, lactose (in the absence of a bulky flavoring agent like cocoa, 2%, with a total solids content of 43 to 54%. For Ice Milk, butterfat is 3 to 7%; skim milk solids, 15 to 17%; sweetening agents, 18 to 24%. For Sherbets, butterfat is 2%; skim milk solids, 5%; sweetening agents, including corn syrup solids, 42%—52%.

The percentage of butterfat and skim milk solids in sherbet mixes is limited, as above indicated, and I increase the solids content by increasing the amount of sweetening agent and using a considerable proportion of corn syrup solids. I can increase the solids content by adding lactose (which has a lower sweetening effect than sucrose); thus I may add 2% lactose to the formula of Example 3 below, and reduce the proportion of water correspondingly.

A stabilizer is used in the proportion by weight of about 0.1% to 0.5%; and the emulsifier amounts to about 0.1% to 0.2%. The mixes may also contain standard flavouring agents, such as vanilla or chocolate. Fresh, sweet cream is the most desirable concentrated source of butterfat for use in the mixes. However, unsalted butter and butter oil may also be used. If a product containing vegetable fat is desired, partially hydrogenated vegetable oil or other acceptable non-animal fats may be used.

The use of high heat skim milk solids (i.e., one produced by spray drying at temperatures of 190°F. or above) is of advantage and these constitute at least part of the milk solids.

The usual diabetic ice cream mix contains: Butterfat, 16%; Skim Milk Solids, 7% to 10%; Sorbitol, 7% to 9%, with a total solids content of 30 to 35%. In my improved diabetic mix, the butterfat remains the same, but the skim milk solids are increased to 10.4% to 14%, and the sorbitol to 14% to 18%, while the total solids are increased to 40.4% to 48%.

The usual or standard diatetic ice cream mix includes butterfat, skim milk solids, and crystalline sorbitol; and has a total solids content of 25% to 32%. In my improved mix, the total solids are increased to 33% to 42% and include additionally gum arabic or other vegetable gum.

Various kinds of sweetening agents may be used, including cane and beet sugar, corn syrup and its solids, and lactose. In diabetic mixes, sugar substitutes, like sorbitol, can be used, as well as synthetic sweeteners.

The emulsifiers can be those commonly used in commercial ice cream manufacture, such as mono- and di-glycerides of the higher fatty acids, as well as sorbitan and polyoxyethylene derivatives. A highly satisfactory emulsifier is one known as "TM 100VS", which is a mixture of 80% mono- and di-glycerides and 20% polyoxyethylene sorbitan stearate. Egg yolk can also be used. These have been found to provide uniform whipping action and yield a product with smoother body and texture.

The stabilizers aid in preventing formation of objectionably large ice crystals. They include seed gums, such as locust bean gum, gelatin (0.3% to 0.5%) seaweed derivatives, carrageenins and cellulose gums.

In packaging the mixes in pressurized containers, they are charged into the container in an amount insufficient to fill it. The gas or mixture of gases is then introduced into the container under a pressure such that the gas or vapour pressure at room temperature is about 80 to 100 lbs./sq. in (5.62 to 7.03 kg./cm.). The gases which may be used include nitrous oxide, carbon dioxide, non-toxic polyfluoro- and poly-(chloro-fluoro)-lower alkanes, like monochloro- pentafluoroethane ("Freon 115"), and octafluoro-cyclobutane, or any other gases suitable for admixture with foods, alone or in admixture with one another. Preferably, if a combination of nitrous oxide and carbon dioxide is used, the amount of carbon dioxide is less than about 30% of the total gas mixture. Similarly, when a mixture of nitrous oxide and "Freon 115" is used, it is preferred to employ a mixture containing about 70% nitrous oxide and 30% of the "Freon 115" "Freon" is a Registered Trade Mark.

It is desirable to provide in the aerosol can a reservoir of liquefied gas which will evaporate as the volume of liquid mix falls and the pressure likewise tends to fall, so that adequate pressure is maintained. With a mixture of 75% "Freon 115" and 25% "Freon 218" in liquid form (the latter acting to depress the vapour pressure of the former) is used, a larger proportion of the contents of the pressurized container can be discharged under high pressure. The proportions of the "Freon 115" and "Freon 318" can also be 60:40 or 50:50 by weight.

The gases and their proportions are so selected as to provide the stated pressure at room temperature. The "Freon" gases mentioned can be mixed with nitrous oxide and the latter can sometimes be used alone. Usually about 7 to 15 grams of gas in a pint size (0.47 litre) can will be sufficient. A mixture of 4 to 5 grams of nitrous oxide and 2 grams of "Freon 115" has been found to be satisfactory for 12 oz. (0.36 litres) of mix in the pint can.

In any case, enough soluble gas is charged into the can to ensure continuous whipping action by the expanding gas as the container valve is opened. Even though the "Freon" gases mentioned above are not very soluble, yet when the can is shaken, enough becomes suspended in the mix, aided by the emulsifier, to expand and whip the mix on discharge.

By the term "maximum of corresponding standard preparations", as employed in the claims, is meant known ice cream, ice milk, and sherbet mixes having respectively, the commercially usual maximum total solids content disclosed hereinabove.

Various mixes according to the invention are presented below by way of illustration, but the invention is not limited thereto.

EXAMPLE 1

Vanilla Ice Cream Mix (10% Butterfat)

	% by weight
Heavy Cream (36% fat)	27.8
Skim Milk Powder	14.
Cane Sugar	10.
Corn Syrup Solids (42% Dextrose Equivalent)	6.6
Sodium Caseinate	0.4
Lactose	2.
Locust Bean Gum	0.13
Carrageenin	0.02
Emulsifier ("TM100VS")	0.2
Calcium Sulphate	0.2
Vanilla Extract	0.0225
Vanilla Oleoresin (6 oz. strength)	0.0225
Water	38.605
	100.00 %

"6-oz. strength" is a measure of the vanillin concentration in the oleoresin and is the quantity dissolved in 1 gallon of aqueous alcohol; this gives what is termed a "1-fold concentration".

The total solids content of this mix, excluding the vanilla flavoring agent, was 45.02%.

This composition was pasteurized at 160°F. for 30 minutes and homogenized. Then, 10 oz. of this mix was placed in a 16 oz. container, and a mixture of 30% "C-115 Freon" and 70% nitrous oxide was introduced into the container at a pressure of about 100 lbs./sq. in. (7.03 kg./sq. cm.) at room temperature. The mix was then placed in a refrigerator for a short period of time, and then discharged from the aerosol container into a suitable dish. The soft ice cream product obtained, despite an overrun of over 200%, was firm, had the smooth feel and consistency of a mousse, and was found to

have a pleasing taste and flavor, comparable to commercial vanilla ice cream. On freezing, it suffered no noticeable loss of volume and no crystallization of sugar was observed. The ice cream product was not heavy, soggy, or sticky. It had a pleasing lightness without being fluffy, and had a desirable "chewiness".

EXAMPLE 2

Vanilla Ice Cream Mix (16% Butterfat)

	% by weight
Heavy Cream (40% butterfat)	40.
Skim Milk Powder	12.35
Cane Sugar	9.
Corn Syrup Solids (42% D.E.)	5.6
Sodium Caseinate	0.4
Lactose	2.
Locust Bean Gum	.11
Carrageenin	.02
Emulsifier ("TM100VS")	.2
Vanilla Extract	0.0225
Vanilla Oleoresin ("6 oz. strength")	0.0225
Calcium Sulphate	.2
Water	30.075
	100.00 %

The total solids content of the mix, exclusive of the vanilla flavouring agent, was 48%.

The mix was treated as described in Example 1, and a product was obtained which was similar to the product of Example 1, with the taste, body, texture and general palatability of commercial ice cream of equivalent fat content, all despite an overrun of about 240% and an increase in solids content of only about 10%.

EXAMPLE 3

Ice Milk Mix (6% Butterfat)

	% by weight
Heavy Cream (40% butterfat)	15.
Skim Milk Powder	15.
Cane Sugar	10.
Corn Syrup Solids (42% Dextrose Equivalent)	6.6
Lactose	2.
Sodium Caseinate	.4
Locust Bean Gum	0.13
Carrageenin	0.02
Calcium Sulphate	0.2
Emulsifier ("TM 100VS")	0.2
Vanilla Extract	0.0225
Vanilla Oleoresin ("6 oz. strength")	0.0225
Water	50.405
	100.00 %

The total solids content, exclusive of the vanilla flavouring agent, was 41.33%.

The mix was treated as described in Example 1.

The product obtained from such a mix was comparable in taste and body to commercial ice milk, even though the overrun was about 210% from a pressurized container with the above-described mixture of "Freon" gas and nitrous oxide at a pressure of about 100 lbs./sq. inch (7.03 kg./sq.cm.).

EXAMPLE 4

Diabetic Ice Cream Mix

	% by weight
Heavy Cream (40% butterfat)	40.
Condensed Skim Milk (30% serum solids)	26.27
Sorbitol Solution (70%)	20.
Sodium Caseinate	0.4
Calcium Cyclamate	0.04
Saccharin	0.01
Locust Bean Gum	0.12
Carrageenin	0.02
Calcium Sulphate	0.2
Emulsifier ("TM 100VS")	0.2
Vanilla Extract	0.0225
Vanilla Oleoresin ("6 oz. strength")	0.0225
Water	12.695
	100.00 %

The total solids content of the mix was 40.95%.

The mix was treated as in Example 1, and the diabetic product obtained was comparable in taste and body to commercial ice cream. The overrun was about 205%, but neither the soft product discharged by the aerosol container nor the frozen product was fluffy or foamy.

EXAMPLE 5

Sherbet Mix

	% by weight
Heavy Cream (40% butterfat)	5.
Skim Milk Powder	4.74
Cane Sugar	30.
Corn Syrup Solids (42% Dextrose Equivalent)	12.
Locust Bean Gum	0.14
Carrageenin, Type 2	0.02
Calcium Sulfate	0.2
Emulsifier ("TM 100VS")	0.2
Citric Acid	0.35
Water	47.35
	100.00 %

The total solids content of the mix was 48%.

The mix was treated as described in Example 1. The product so obtained was comparable to the commercial standard sherbet.

There can be added to the mix a synthetic fruit flavouring agent in the usual small proportion, or a suitable quantity of a strained natural fruit juice, the amount of water being reduced correspondingly. The properties of the frozen product can be modified by varying the proportions of the skim milk powder and of the sugars.

EXAMPLE 6
Dietetic Ice Cream Mix

	% by weight
Heavy Cream (40% butterfat)	10.
Skim Milk Powder	18.
Crystalline Sorbitol	10.
Gum Arabic	8.
Locust Bean Gum	0.1
Emulsifier ("TM 100VS")	0.2
Calcium Sulfate	0.2
Calcium Cyclamate	0.25
Vanilla Extract	0.0225
Vanilla Oleoresin ("6 oz. strength")	0.0225
Water	53.205
	100.00 %

The total solids content of the mix, excluding the vanilla flavouring agent, was 41.27%.

The mix was treated as in Example 1. The refrigerated mix was discharged from the pressurized container at an overrun of over 200%. The mass was firm and smooth and showed no loss in volume on freezing; it was comparable in taste and body to commercial dietetic ice cream.

EXAMPLE 7
Chocolate Ice Cream Mix

	% by weight
Heavy Cream (36% butterfat)	27.8
Skim Milk Powder	11.0
Cane Sugar	13.
Corn Syrup Solids (42% D.E.)	6.
Sodium Caseinate	0.4
Calcium Sulphate	0.2
Emulsifier ("TM 100VS")	0.2
Locust Bean Gum	0.12
Carrageenin	0.02
Cocoa	3.5
Vanillin	0.05
Water	37.71
	100.00 %

On discharge of the above mix from a refrigerator-cooled aerosol container, which was at about 100 lbs./sq. inch (7.05 kg./sq. cm.), the propellant and whipping agent consisting of a mixture of "Freon" gas and nitrous oxide, there was obtained a chocolate mousse-like product resembling soft ice cream of extreme smoothness and excellent flavour and which, despite its considerably lower solids content per quart (or litre) than commercial chocolate ice cream, maintained its shape for a considerable time at room temperature, remained free from bleeding, was highly palatable with good body, and on freezing, retained its original volume and had a body, texture, rate of melting in the mouth and general palatability at least equal in all respects to a high grade of ice cream. The overrun was about 235%.

I am aware of the Artificial Sweeteners in Food Regulations, 1969, and insofar as my invention relates to the manufacture for sale in the United Kingdom and/or sale in the United Kingdom of food products containing a cyclamate I make no claim to use the invention in contravention of the law.

WHAT I CLAIM IS:—

1. A confectionery food package comprising a food mix packaged in an aerosol dispenser under the pressure of a gaseous propellant partially dissolved in the mix, wherein the food mix is a substantially homogeneous aqueous suspension containing the components of ice cream, ice milk or sherbet, the solids content of the mix consisting essentially of an edible fat, milk solids non fat, and a sweetening material, with smaller proportions of one or more emulsifying, stabilizing, thickening or flavouring agents, the total solids content of the ice cream, ice milk or sherbet mix being in the range of respectively, 43% to 54%, 37% to 47% and 42% to 59%, the gas being dissolved in the mix to such a degree that on discharge from the dispenser in the chilled condition the mix is whipped by the expanding and escaping gas to an overrun of at least 160% in the case of ice cream and ice milk mixes or of at least 80% for sherbet mixes and yields an expanded mass which can be frozen to form an ice cream, ice milk or sherbet type of product.

2. A package according to claim 1, wherein the mix is an ice cream mix containing 10% to 16% of edible fat, 11% to 17% of milk solids non-fat, and 17% to 25% of sweetening agents.

3. A package according to claim 1, wherein the mix is a sherbet mix containing 1% to 3% of edible fat, 3% to 7% of milk solids non-fat and 42% to 52% of sugar.

4. A package according to claim 1, wherein the mix is an ice milk mix containing 2% to 7% of edible fat, 15% to 17% of milk solids non-fat, and 18% to 24% of sweetening material.

5. A package according to any of claims 1 to 4, wherein the edible fat is butter fat.

6. A package according to any of claims 1 to 5, wherein said mix contains 0.1% to 0.5% of stabilizer and 0.1% to 0.2% of emulsifier.

7. A package according to claim 1 or

claim 2, wherein the mix is an ice cream mix and includes a small proportion of calcium sulphate.

8. A package according to claim 7, wherein the sweetening agent includes lactose in a proportion of substantially 2% of the mix.

9. A package according to any of the preceding claims wherein the sweetening material includes one or more artificial sweeteners.

10. A confectionery food package comprising a pressurized valved container having therein an aqueous ice cream mix together with propellant gas under pressure, a part of the gas being dissolved in the mix, the composition and solids content of the mix being such that on discharge of the mix from the container, it is whipped with an overrun of at least 160% into a form-retaining mass of mousse-like body and smoothness of texture which can be frozen to a product of the type of ice cream without separation of liquid and without any substantial production of stockiness or gumminess, wherein the mix contains the following components in the proportions stated:—

Fat	10% to 16%
Skim Milk Powder	11% to 17%
Sweetening Agents	17% to 25%

together with one or more stabilizing, emulsifying and flavouring agents, the balance of the mix being substantially all water.

11. A package according to claim 10, wherein the mix contains the following components in the proportions stated:—

Fat	10 % to 16 %
Skim Milk solids	12.35% to 14 %
Cane sugar	9 % to 10 %
Corn syrup solids (42% Dextrose Equivalent)	5.6 % to 6.6%
Lactose	2 %

together with one or more stabilizing, emulsifying and flavouring agents, the solids content of the mix being at least 43% by weight.

12. A package according to claim 10, wherein the mix contains the following components in substantially the stated proportions:—

Fat	10 % to 16%
Skim Milk Powder	11 %
Cane sugar	13 %
Corn Syrup Solids (42% Dextrose Equivalent)	6 %
Cocoa	3.5%

together with stabilizing and emulsifying agents, and the balance being substantially all water.

13. A food package comprising a pressurized valved container having therein an aqueous diabetic ice cream mix together with propellant gas under pressure, a part of the gas being dissolved in the mix, the composition and solids content of the mix being such that on discharge of the mix from the container it is whipped with an overrun of at least 160% into a form-retaining mass of mousse-like body and smoothness of texture which can be frozen to a product of the type of ice cream, the mix containing the following components in substantially the stated proportions:—

Heavy Cream (40% butterfat	30 % to 40%
Condensed skim milk (30% serum solids)	26 % to 30%
Sorbitol solution (70%)	20 %
Synthetic sweetening agents	0.05%

together with one or more stabilizing, emulsifying and stiffening agents, the balance of the mix being substantially all water.

14. A food package comprising a pressurized valved container having therein an aqueous dietetic ice cream mix together with propellant gas under pressure, a part of the gas being dissolved in the mix, the composition and solids content of the mix being such that on discharge of the mix from the container, it is whipped with an overrun of at least 160% into a form-retaining mass of mousse-like body and smoothness of texture which can be frozen to a product of the type of ice cream, the mix containing the following components in substantially the stated proportions by weight:—

Heavy cream (40% butterfat)	10%
Skim milk powder	18%
Crystalline Sorbitol	10%
Gum arabic	8%

together with one or more stabilizing, emulsifying, flavouring and stiffening agents, the balance of the mix being substantially all water.

15. A package according to any of claims 10 to 14, wherein the pressure in the container and the composition of the mix are such that an overrun of from 160% to 250% is obtained.

16. A package according to claim 15, wherein the overrun is from 200% to 250%.

17. A package according to any of claims 10 to 16, wherein the mix includes 0.1% to 0.5% of stabilizer and 0.1% to 0.2% of emulsifier.

18. A package according to any of claims 10 to 17, wherein the mix contains small

proportions of an emulsifying agent, a stabilizing agent, and calcium sulphate.

19. A package according to claim 18, wherein the sweetening agent includes lactose in an amount of substantially 2%.

20. A package containing a mix as claimed in any of claims 10 to 19, wherein the mix includes a small proportion of calcium sulphate.

21. A package as claimed in any of claims 10 to 20, wherein the sweetening material comprises one or more artificial sweeteners.

22. A package according to any of the preceding claims, wherein the gaseous propellant is monochlorpenta-fluoro ethane, octafluoro-cyclobutane, nitrous oxide or carbon dioxide, or a mixture of two or more of these gases.

23. A package according to any of the preceding claims, wherein the mix includes small proportions of sodium caseinate and of an edible, slightly-soluble calcium salt.

24. A food package as claimed in any of claims 1, 10, 13 and 14 and substantially as herein described.

25. The method of preparing a mix as defined in any of the preceding claims, in a frozen condition, which comprises introducing the mix into a container provided with a valve-controlled discharge nozzle, charging the container with a partially soluble gaseous propellant, chilling the container and discharging the mix from the container to provide an expanded, form-retaining mass with an overrun of at least 160% in the case of ice cream and ice milk mixes or of at least 80% for sherbet mixes, and freezing such mass to form an ice cream, ice milk or sherbet type of product.

26. A process for the manufacture of a dispensing unit for the substantially instantaneous preparation of a form-retaining mass of whipped mix of the type of ice cream which is capable of being frozen to form a product of good body, texture and palatability, which comprises packaging a homogeneous aqueous ice cream mix in a valved container, and placing the interior of the container under gas pressure with the aid of a gas which is soluble in the mix, said mix containing cream, skim milk solids, sweetening material, an emulsifier, a stabilizing agent, a flavouring agent and water, the total solids content of the mix ranging from 43% to 54%, so that upon opening of the container valve, after chilling the container, the mix is discharged with simultaneous whipping thereof to an overrun of 160% to 250% by the expansion of the gas dissolved therein to yield a form-retaining expanded mass which is capable of being frozen to an ice cream type of product.

27. The method of preparing a frozen confection composed of an ice cream mix as defined in any of claims 1 to 25, which comprises introducing the mix into a container provided with a valve-controlled discharge nozzle, charging the container with a partially soluble gaseous propellant, chilling the container and discharging the mix from the container to provide an expanded, form-retaining mass with an overrun of at least 160%, and freezing this mass to form an ice cream type of product.

28. A process for the manufacture of a dispensing unit for the substantially instantaneous preparation of a form-retaining mass of whipped mix of the type of ice cream which is capable of being frozen to form a product of good body, texture, and palatability, which comprises packaging a homogeneous aqueous ice cream mix in a valved container, and placing the interior of the container under gas pressure with the aid of a gas which is soluble in the mix, wherein the mix contains 10% to 16% of butterfat, 11% to 17% of skim milk solids, from 17% to 25% of sweetening material, and small amounts of an emulsifier, a stabilizing agent and a flavouring agent, the total solids content of the mix being from 43% to 54%, the balance being substantially water, so that upon opening of the container valve, after chilling the container, the mix is discharged with simultaneous whipping thereof to an overrun of from 160% to 250% by the expansion of the gas dissolved in the mix to yield a form-retaining expanded mass which is capable of being frozen to form an ice cream type of product.

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